JOURNAL

OF THE INSTITUTION OF
ELECTRICAL ENGINEERS

VOLUME 7 NUMBER 80 NOVEMBER 1961

VOLUME 7 NUMBER EIGHTY-THREE NOVEMBER 1961

JOURNAL

OF THE INSTITUTION OF ELECTRICAL ENGINEERS

SAVOY PLACE LONDON W.C.2 *Telephone* COVENT GARDEN 1871 *Telegrams* VOLTAMPERE PHONE LONDON

PUBLISHED MONTHLY PRICE SEVEN SHILLINGS ANNUAL SUBSCRIPTION TWO POUNDS

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NUCLEAR ELECTRONICS

THIS month's cover illustration shows a routine health-physics survey being carried out on the beach of the Halladale estuary, some miles from the Dounreay Experimental Reactor Establishment. The Institution, in conjunction with the British Nuclear Energy Conference, is organizing a symposium on nuclear electronics (see p. 663) in which radiation detectors, monitors and instruments figure prominently

Secretary W. K. BRASHER, C.B.E., M.A., M.I.E.E. *Editor* W. G. ASKEW, M.C.

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SAVOY PLACE LONDON W.C.2 VOLUME 7 NUMBER 83 NOVEMBER 1961

SYSTEMS OF MEASUREMENT

MUCH is heard today about the United Kingdom's obsolete system of measurement and units of measurement. Those with the least knowledge of the subject are often the most vocal in running down the present Imperial system and in advocating a change, while those with most to gain or lose by a change are frequently the most hesitant, waiting to see what their neighbours are going to do and seeking an assurance that any change that is made will be one that the country as a whole will adopt.

Leadership is the most pressing need at the moment, and this can only come in the first instance from the Government. The broad outline of policy that will govern the United Kingdom's system and units of measurement over the next 50 years can emanate only from a Government pronouncement and Parliamentary action. The detail and the timing of any change are best left to individual industries, which, once the pattern of the future is clear, are well able to work out the detail for themselves.

Several authoritative documents have recently appeared on specific aspects of this problem. There is the Weights and Measures (No. 2) Bill, waiting in the Parliamentary queue; but this is mainly of legal significance and eliminates a few of the most obsolescent units in the Imperial system. There is the detailed report published in May 1960 by the British Association for the Advancement of Science and the Association of British Chambers of Commerce. There are recent pronouncements by both the Federation of British Industries and the Institute of Chartered Accountants, which call for an early move towards a decimal coinage. There is a 'broadsheet' recently published by P.E.P. (Political and Economic Planning)—an independent and non-party organization that aims 'to study problems of public concern, to find out the facts, to present them impartially. . . .'—which, in effect, advocates a complete swing over to the metric system.

A common feature of these publications is that they all advocate *some change*, although they focus their attention on different aspects of the problem and vary a good deal in their recommendations and in the timing of any change. Indeed, it would seem that there is an overwhelming majority view among responsible leaders of political and industrial thought in favour of some changes, and on the whole substantial changes, from the Imperial system.

Of all the recent documents on the subject, the B.A. and A.B.C.C. report is by far the most detailed. Its critics have mostly claimed that it does not go far enough; few, if any, suggest that it goes too far or too fast. Its principal recommendations might therefore be taken as common ground among responsible opinions in the United Kingdom. What are its main recommendations?

First, the promotion of 'decimal thinking', particularly in schools and colleges. The change, if it should come, will strike hardest at the junior and middle administrative and technical people in industry, whose minds will have to be trained afresh to think alertly in the new units. However, 15 years or less represents a new generation of this age group; and, if a beginning were to be made now with training in decimal thinking, industry would be far better placed later on to accommodate any changes that might then come about.

Secondly, the introduction of a decimal coinage. The desirability of this is no longer in question. The detail and timing are all that remain to be decided, and here the initiative must come from the Government, who so far have shown a marked tendency to follow rather than lead. It seems probable that the United Kingdom will be the last member of the Commonwealth to effect this change.

Thirdly, a steady rationalization and decimalization of existing Imperial units of measurement, including weights, volumes, temperatures, etc.

Fourthly, an extension in the use of decimalized increments of the inch and other units of linear measurement in engineering, as opposed to the use of the fractions 1/8, 1/16, 1/32, etc.

Fifthly, the report says that, after careful consideration, 'the Committee cannot recommend compulsory adoption of the metric system by the U.K. at the present time'. It goes on, however, to foresee a wider use of the metric system in the rest of the world and in the United Kingdom as time goes on and anticipates that specific industries or sections of industry will gradually move over to the full metric system.

Many industrialists are now asking themselves whether these recommendations represent an adequate step for the time being, or whether it would be better to make a clean sweep and move right over now to the full metric system. There can surely be no one straight answer to this question, which must be studied industry by industry within the broad pattern of a national policy. While an immediate and full changeover may be practicable for some industries (the pharmaceutical and photographic, for example), it is quite impracticable for most of the engineering industries. For them, there is so much 'know-how' and capital investment tied completely to the inch that only gradually, and on new designs, could a changeover to metric dimensions be made—a process that must take 20 and could take as long as 50 years.

Thus, however attractive may be the proposal to make one big change and get it over quickly, this is unlikely to prove a feasible proposition except in very rare cases. Such a change would need very careful pre-planning and a long transitional period during which both systems would be in use and parts

would be manufactured to both inch and metric standards. It must be remembered that there will still be a call for replacements and spares for existing equipments.

From this general survey, let us turn to the electrical industries and examine what might be their particular problems in any movement towards the metric system. At first sight it might seem that for these industries the transition would be a simple one. Electricity is a comparatively new subject, which came into application after the creation of the metric system, and so it is only natural that all the primary units and quantities in the science of electricity should have been founded on C.G.S. units. It is only where electricity merges with mechanics that units such as the inch, the foot, and the pound have prevailed in the Anglo-Saxon countries, notably in expressing such quantities as force, torque, speed, etc. and, of course, in denoting the dimensions of equipment.

So, although the scientist and the student of electrical technology would almost certainly welcome a further swing towards the metric system, some manufacturers—especially those of heavy equipment—might be reluctant. For them the problem would be much the same as for the mechanical engineer—so much 'know-how' and complicated manufacturing technique wrapped up in the inch, and so much expensive capital equipment tied to producing parts with inch dimensions. In the electronics and lighter sections of the electrical industries, a full changeover might well be accomplished in a fairly short space of time, but the manufacturers of heavier electrical equipment would find it difficult and expensive to effect any change rapidly. For them, the transition would need to be gradual and phased with the introduction of new designs.

Even for such simple things as electric cables, where dimensions are commonly used as a form of designation, there would be a major problem. Electricians are trained to memorize, for example, the carrying capacity of a 7/·029 cable, the curvature that this cable can be bent to, the nominal size of conduit through which it can be threaded, and many other such details. If there were to be a sudden change to the nearest equivalents in the metric system, many mistakes could be expected initially. Designations are, however, largely a matter of education, and the importance of an early start with education has already been stressed.

It seems, therefore, that for the electrical industries, as for others, changes must be gradual, and individual sections must be left to decide on their extent and timing.

Nevertheless, some changes would seem to be inevitable. Leadership is the most vital need at present, and an authoritative pronouncement on broad national policy ought not to be long delayed. Individuals could then begin to make a careful study of the implications within their own spheres of operation and fix their own time-schedule for such changes as they decide to make.

REVISION OF THE WIRING REGULATIONS

The Council of The Institution have authorized the Wiring Regulations Committee to proceed with the preparation of a 14th Edition of the Regulations (see p. 660).

It is now almost 80 years since 'Rules and regulations for the prevention of fire risks arising from electric lighting' (as it was then called) was first issued on the authority of the Council of The Institution. The committee that drafted it was broadly based but did not contain direct nominees of interested bodies. For the 5th Edition (1907), the Wiring Rules Committee included representatives of the Municipal Electrical Association and some of the principal fire offices, and it was appointed a standing committee by the Council. The Cable Makers Association and the Engineering Standards Committee also co-operated in the preparation of that edition.

Since that time, the membership of the Wiring Regulations Committee has been extended to provide balanced representation of all the organizations directly concerned with the use of the Regulations. The present Committee (October 1961) includes, besides the Chairman, 12 members appointed directly by the Council and 32 members nominated by interested organizations.

Since 1907 also, arrangements have existed for the Wiring Regulations Committee to consider suggestions for amendment of the Regulations, not only by the organizations directly represented on the Committee but also by individuals needing the Regulations for their work, or by others such as oversea organizations that have adopted the Regulations for use in their countries. There has thus grown up a tradition of adherence by consent to the Regulations.

Accordingly, an invitation is now extended to all users of the Regulations to submit their comments on, or proposed amendments to, the present (13th) Edition. Comments should be addressed to the Secretary of The Institution so as to arrive not later than the 1st January 1962 and should relate only to the 13th Edition with 1958 and 1961 Amendments.

Matters referred to in the abstracts of interpretations of the 13th Edition that have been issued from time to time will be reviewed in the course of the work for the 14th Edition, and there is no need to call further attention to these; nor need past inquirers who have been informed that their comments will be considered for the 14th Edition write again.

For the 13th Edition, issued in September 1955, the Regulations were completely reviewed and recast. Amendments were issued in December 1958 to take account of changes in British Standards and in statutory regulations referred to in the 13th Edition, in particular by the issue of B.S. 3052—'Electric shaver supply units', the preparation of which was requested by the Wiring Regulations Committee. The 1958 Amendments also incorporated a revised Regulation 507 and Note—Test of effectiveness of earthing, to take account of experience gained in the technique of earth-loop testing.

The Council of The Institution have now authorized the issue of further amendments, to take effect from the 1st November 1961, mainly relating to cables (see p. 692).

Other matters arising from developments in standardization and practice since the issue of the 13th Edition are under consideration by the Wiring Regulations Committee. The issue of further substantial amendments would be cumbersome and inconvenient, particularly since the sections on cables are likely to be further affected; and the preparation of a new edition has therefore been agreed.

It will be realized that the existing edition remains in force until the promulgation of a new edition. Although the time necessary for the preparation of the new edition is difficult to forecast with precision, it can be stated that the 14th Edition will not be promulgated before the 31st December 1962.

An electrical engineering review

METAL AND SEMICONDUCTOR RECTIFIERS

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Silicon, germanium, selenium and copper-oxide rectifiers are all widely used today and are continually finding new applications. The review of their characteristics in this article provides a guide to the most suitable type for outputs up to 100 MW. The author is with Westinghouse Brake and Signal Co. Ltd.

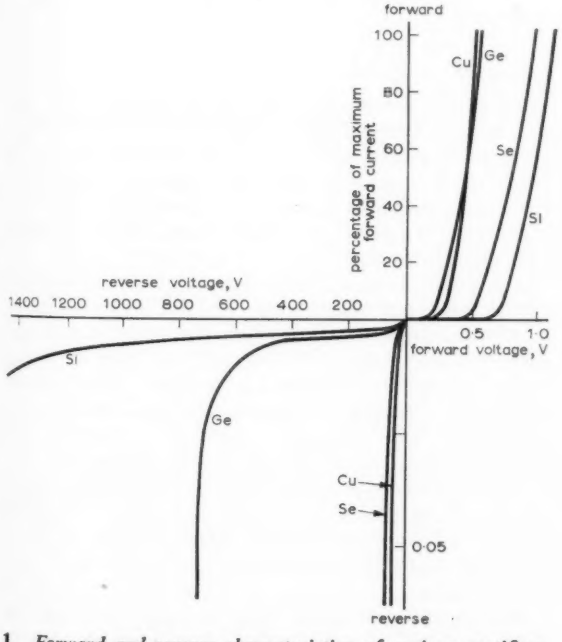
D. ASHBY, B.SC., MEMBER

A RECTIFIER operates as an automatic switch, closing for one half-cycle to allow the free passage of current and opening for the successive half-cycle to prevent current flowing in the opposite direction.

The switching action may be mechanical (such as a synchronous commutator or contactor) or electrical, using combinations of materials that have a low electrical resistance when measured in one direction but a very high resistance when measured in the opposite direction. Rectifier valves and the mercury-arc rectifiers are static rectifiers exhibiting this asymmetrical resistance; copper oxide and selenium have similar characteristics and together are popularly known as 'metal' rectifiers; germanium and silicon materials exhibit this asymmetry to a greater degree and form the 'semiconductor' rectifiers.

Types of rectifier

In the copper oxide rectifier, copper discs are oxidized in a furnace to form a cuprous oxide surface on one side, the copper–cuprous oxide junction forming the rectifier. This type was earlier used for power applications up to several kilowatts but now is used only for instrumentation and in telecommunication circuits.



1 *Forward and reverse characteristics of various rectifiers, based on d.c. measurements*

In the selenium rectifier a steel or aluminium plate supports a layer of selenium on which is sprayed a tin–cadmium alloy, the selenium–alloy junction being the rectifier junction. Selenium is still extensively used for powers up to 10 kW and has been satisfactorily used for over 1 MW of d.c. power.

Very pure germanium is alloyed to indium, forming a rectifier capable of operating at high voltages and very high current density. The junction is sensitive to moisture and contamination, and so it is hermetically sealed.

Silicon, the most recent addition, employs silicon and aluminium in a similar way to germanium. It can withstand even higher voltages and operating temperatures and is the most important rectifier for the future.

Other rectifiers, depending on chemical action, have been widely used, but they are inferior to the four described above.

Resistance characteristics

The voltage across any rectifier cell must be increased above a threshold before current passes. The current then rises rapidly with increasing voltage. Thereafter, current increases in proportion to the increase in voltage, with no limitations apart from heating, i.e. there is no saturation condition that limits current.

At full rated current, copper oxide and germanium have the lowest forward-voltage drop—about 0·5 V d.c., followed by selenium at about 0·8 V d.c. and silicon at about 1·1 V d.c.

The leakage current through any rectifier cell is very low at low reverse voltages, increasing little as the reverse voltage increases, until a point is reached when the leakage current rises rapidly with increase in voltage. The high reverse losses then cause severe internal heating and will destroy the rectifier if the condition is maintained.

The runaway point when the leakage current becomes excessive varies enormously for the differing rectifiers, being about 10–30 V d.c. for copper oxide, 40–60 V d.c. for selenium, 500–700 V d.c. for germanium and 1·5–2 kV d.c. for silicon. Their characteristics are shown in Fig. 1.

The forward resistance of all types of rectifier tends to fall with increase in temperature over the working range. The reverse resistance of copper oxide and selenium follows the same course, while that of germanium and silicon alters little over the working range but falls rapidly for higher temperatures, thus setting a limit to the operating temperature.

Current density

There is a fundamental difference between copper oxide and selenium on the one hand and germanium and silicon on the other. The semiconductor rectifiers operate at 1000 times higher current density than do the metal ones. Both selenium and copper oxide operate at around 100 mA/cm^2 of rectifier surface—this being the mean value of current over a whole cycle—while silicon and germanium can safely be run at 100–300 A/cm^2—about the same current density as a copper conductor.

The current density can be increased for a very short period to ten times these values or more, being limited only by cooling.

Operating temperature

If the rectifier junction temperature exceeds a safe value, the leakage current in the reverse direction will rapidly increase, producing ever-increasing reverse losses that ultimately destroy the rectifier. The temperature of the rectifier junction is determined by the ambient temperature, the losses produced by the forward current and the reverse voltage, and the facilities for dissipating these losses. All these factors must be considered in determining a safe rating.

Copper oxide is now used only for low-current purposes where self-heating is negligible. The ambient temperature should be limited to 55°C.

Selenium rectifiers are made by various processes. The conventional type will operate with an element temperature of 70°C, while special rectifiers can operate up to 90°C. The element temperature can be taken as being a few degrees above that of the adjacent cooling fin, measured near where it contacts the element. Many years' life can be expected if this temperature is not exceeded. If the rectifier operates at a slightly higher temperature, it will not fail immediately, but its life will be reduced by a permanent increase in the forward resistance, leading to a reduced current output.

Germanium rectifiers show a rapid increase in leakage current and hence reverse losses when the junction temperature exceeds 85°–90°C, corresponding to about 70°C measured at the base of the diode. Designers generally base their rating data on a base temperature of 50°C to allow some capacity for overloads. Excessive temperature, even for a short time, may result in the destruction of the diode.

The maximum operating temperature of the silicon rectifier is influenced by the type of solders used to secure good thermal contact between the components of the diode. If high-temperature solders are used, the junction temperature can approach 200°C with safety, but a lower junction temperature of 150°C is recommended where soft solders are employed in the construction of the diode assembly. Soft solders have the added disadvantage of a restricted life where operational conditions result in current cycling and hence repeated temperature changes at the junction, which lead to alterations in the structure of the solder and an increase in the temperature gradient between junction and base. The temperature of the base of the diode is about 25°C lower than the junction temperature.

As in germanium, the reverse losses rise steeply beyond these temperatures, and diodes may be immediately destroyed if the rectifier is allowed to overheat while reverse voltage is applied.

Cooling

Practically all the cooling systems employed in dissipating the electrical losses of electrical equipment have been used for rectifiers. While natural air cooling is cheap and economical in space for lower powers, enhanced cooling is desirable when the losses are greater, such as for d.c. outputs of 100 kW or more. Fan cooling is satisfactory if the air is reasonably clean; but, where the atmosphere is corrosive, oil cooling of selenium or water cooling of germanium and silicon may be preferred.

Water cooling by mounting the germanium or silicon diodes on a hollow busbar reduces the space and busbar length, allows the diode temperature to be closely controlled and the rectifier losses to be removed without heating the room, and has proved very popular for plating and electrochemical installations of several-megawatt capacity.

Overload capacity

The heavy metal plate on which copper oxide and selenium rectifiers are mounted, coupled with the low current density, provide a high thermal mass that allows much latitude in operation. Engineers have, therefore, rarely had to consider the overload capacity of the older types of rectifier, as regards both current overloads and voltage surges.

The relatively small thermal mass of germanium and silicon, and their high current density, make the newer rectifiers sensitive to overloads, and these conditions must be carefully considered by the designer, otherwise overloads can lead to disaster. Experience gained in the operation of these new rectifiers has now taught us what restrictions are necessary, enabling a reliable and economic design to be arrived at with confidence.

The massive construction of copper oxide and selenium allowed these rectifiers to be operated at up to ten times full current for many seconds, followed by a period of rest, and this typifies the overload capacity of these types of rectifier.

Silicon and germanium are severely restricted. Ten times full current can be carried for only 0·01 sec. Special precautions against overloads, which are unnecessary in

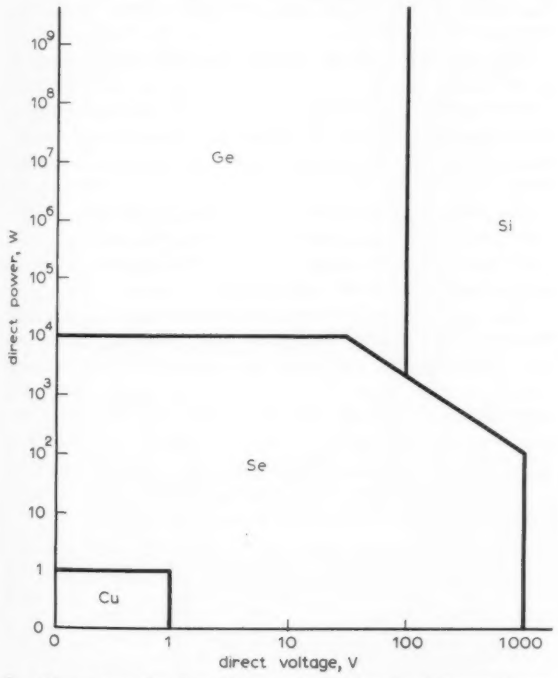
selenium-rectifier installations, are therefore essential. Where overloads cannot occur, the full thermal rating of the diode can be enjoyed; otherwise fuses or protective relays, coupled with some derating, are necessary.

Selenium and copper oxide are not sensitive to reverse-voltage surges that could destroy silicon or germanium diodes. As these new rectifiers are usually employed in higher-power circuits, surge voltages may be of larger magnitude and power level and must be restricted by capacitive-reactance networks, leaving always a safety factor between the peak test voltage of the diode and the repetitive peak voltage in normal operational conditions.

Surges can arise from disturbances in the a.c. network, switching on or off of transformers, distortion in the d.c. system, and commutation in association with the reactance of the system.

Efficiency

The four rectifiers together span the whole range of a.c.–d.c. power conversion, offer a higher efficiency than can be obtained from earlier forms of rectifier—the motor generator and mercury-arc rectifier—and reach the level established by the mechanical-contact rectifier, which is now superseded by silicon.



2 *Suggestions for first choice of rectifier for different direct voltages and powers*

The demarcation between areas is very approximate

The efficiency of a rectifier becomes increasingly important at higher power levels. Rectifier losses increase the size of the transformer feeding the rectifier and present technical and economic problems in dissipation. Efficiency is unimportant at low-power levels, where first cost is generally decisive.

At voltages up to 10 V, germanium offers the highest efficiency. The rectifier losses amount to some 5%, but the over-all efficiency of a rectifier without transformer at this voltage is reduced by the losses in copper connections and protective fuses to 90% or less. A comparable selenium rectifier gives about 87%, while silicon offers 84%.

At 100 V, several selenium elements in series are necessary, and the efficiency amounts to 92% (the busbar losses now being a smaller proportion of the whole). A single germanium cell can be used with an efficiency of 97%, while the slightly-higher-resistance silicon rectifier will give 95%. In each case, transformer losses must be added, together with the losses in interconnecting busbars, which cannot be ignored.

At 400 V d.c.—about the limit of a single-series-cell bridge connection with silicon—the silicon-rectifier cubicle efficiency rises to about 98%, two or more series germanium diodes would be required offering the same or slightly lower efficiency, while selenium with many series plates is reduced to about 90%. Selenium, however, is still economical for powers of a few kilowatts on account of its robustness against overloads, thereby requiring no costly protective relays.

Comparison can be made of the mercury-arc rectifier, having a voltage drop of 15–20 V, with a single-series silicon diode having a voltage drop of about 1 V, suitable for use up to 250 V d.c. Additional series cells are required for higher voltages. Even at 1000 V d.c. the silicon rectifier is not inferior in efficiency to the mercury-arc rectifier.

Practical ratings and applications

It is not possible to give the electrical rating to meet all conditions, because so many limitations govern the operational conditions in which a rectifier may be used; but the following will serve as a guide.

Copper oxide is used only for instrumentation and in telecommunication circuits, and not as a power rectifier.

Selenium is generally operated at 30 V a.c. per series cell. Thus a 3-phase bridge will give 35 V d.c. High-impedance cells are available that operate at higher voltages but only at currents below 1 A.

Germanium is made to withstand peak inverse voltages of several hundred, reckoned as the peak inverse test voltage over the repetitive peak voltage. A safety factor of about 3 is desirable, coupled with surge-voltage limiting devices, so a 3-phase bridge with a single cell is restricted to about 150 V d.c.

Silicon is available for peak mains voltages up to 1200 V and beyond. It is equally susceptible to surges. The output of a single-series-cell bridge is limited to 300 V d.c. but in favourable conditions can be revised to 400 V by using high-grade cells, which, at this voltage, may be handling a power of 12 kW each.

Copper oxide and, later, selenium rectifiers replaced

thermionic valves and, at low voltages, motor generators and established for themselves a dominant position for low-power rectification. In a similar manner, germanium and silicon have become accepted as superseding the mercury-arc rectifier, except in those applications where grid control for voltage variation or for regeneration is demanded.

The introduction of a 'grid' electrode in the silicon-controlled rectifier or static switch provides an opportunity for this achievement, but technical development has not yet progressed sufficiently. However, this is expected within a few years.

Probably the largest power handled by germanium and silicon rectifiers is for aluminium pot lines, where installations are in use giving 100000 A at voltages approaching 1000 V, at a power level of 100 MW.

Choice of rectifier

Despite the arrival of new and improved types of rectifier, the older types still find their uses, while the rapidity with which germanium and silicon have been developed has led to confusion in the minds of many in deciding which is the most appropriate rectifier for their particular application.

The first choice of the best type of rectifier for different direct voltages and powers is indicated in Fig. 2, which is based on current prices complete with technical performance.

Copper oxide offers a cheap, robust rectifier of low forward resistance but operating at a low current density with an ambient-temperature restriction of 55°C.

Selenium rectifiers are cheap and robust and offer reasonable efficiency and bulk for power outputs up to 10 kW. The ambient-temperature limitation is 55°C, but special-process rectifiers can operate at higher ambient temperatures.

The semiconductor rectifiers, germanium and silicon, operate at a very high current density and reverse voltage. With their small thermal mass, both types are critical as to current overloads and reverse-voltage surges, normally allowed for by under-rating the diodes, but they may also demand fast fuses or relays and surge-absorber circuits to obtain an economic rating of the rectifiers.

Germanium offers a low forward loss and so is more efficient than silicon where the operating conditions allow of a single-series cell. Germanium is restricted to an ambient temperature of 35°C, beyond which severe derating may favour silicon. Germanium is thus preferable for outputs above 10 kW at direct voltages below about 100, with temperate operating conditions.

Silicon has double the forward loss of germanium but can operate at double the reverse voltage and so is best used for outputs above 10 kW at above 100 V. As the rectifier junction can run at twice the temperature of the germanium junction, derating for warmer climates is less serious—silicon is the only choice where hot conditions persist.

The excellent performance of the silicon rectifier is unlikely to be improved on by any new combination of materials, so engineers will be increasingly dependent on the silicon rectifier for many years to come.

Summary

Silicon and germanium employ high current densities and accept high inverse voltages and so require over-current and overvoltage protection, economically justified at high power levels, while derating is satisfactory for low powers. Selenium is not affected by transient overloads and so can be protected by fuses; copper oxide is similarly unaffected but is no longer used in power circuits. Silicon withstands much higher temperatures than other rectifiers.

BENEVOLENT FUND: ANNUAL REPORT

THE 1961 Report of the Court of Governors of the Incorporated Benevolent Fund, which was circulated with the September 1961 *Journal*, was presented at the Annual General Meeting of the members of the fund on the 25th October 1961.

Before the meeting, power was conferred, by appropriate resolutions, for the Governors to invest a portion of the funds in equities and to permit past members of the Council to serve on the Court.

The total capital of the fund on the 30th June 1961 stood at £199242.

Subscriptions and donations during the year amounted to £17478, a slight decrease on the previous year, which, however, was almost restored by the higher dividends and interest received on investments.

The support given by local Centres through special functions and collections was commendable, and the fund had benefited appreciably from nine specific legacies and from generous donations from the electrical industry.

The cost of grants plus management and maintenance charges was £17903, which more than absorbed the income from subscriptions and donations, but the Governors were happy to have met all requests for assistance. Help was extended to 126 beneficiaries and dependants during the year, and the Fund still had six nominees resident in the Crossways Trust houses at West Worthing, Brighton, St. Leonards and Englefield Green. These persons were not infirm, but needed accommodation where some attention was provided.

Refund of income-tax. £2327 was recovered from the Income-Tax Commissioners owing to the kindness of members who subscribed by deed of covenant, and an appeal was made to members who have not already done so to consider this method of contribution.

Local Honorary Treasurers. The sincere gratitude of the Court was expressed to the Local Honorary Treasurers for their excellent services in investigating the needs of applicants for assistance.

Homes Fund. The total amount received in subscriptions and donations from the inception of the Homes Fund to the 30th June 1961 was approximately £48000. All the houses on 'The Chesters' estate were occupied, and the occupants were appreciative of the freedom and amenities they enjoyed.

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ELECTRIC TRACTION

Electric traction has a vital part to play in the modernization plan of British Railways. The problems and achievements of the large-scale programme of electrification following the adoption of the 25/6·25kV 50c/s system are described in this article, which is based on the Utilization Section Annual Lecture with the same title, delivered at Savoy Place on the 25th May 1961.

The author is Assistant Chief Electrical Engineer, British Transport Commission.

J. A. BROUGHALL, B.SC.(ENG.), MEMBER

THERE is much more than the correct choice of motive power in running a railway. But the motive power is a big and important component. With the decision inevitably taken, though deferred in Great Britain, to abolish steam, everything would be wasted if a wrong decision about motive power were made.

Choice of motive power

The British Railways modernization plan envisages the use of Diesel engines, with various kinds of drive, and the electrification of heavily trafficked lines. The plan, with its decision to electrify both the London Midland and the Eastern Region main lines, announced in December 1954, demanded a now-or-never decision as to what system to use. For reasons that have frequently been given, the Chief Electrical Engineer, British Transport Commission, Mr. S. B. Warder, recommended, and the Commission decided in favour of, the 50c/s single-phase system, with the dual voltage 25/6·25kV.

This system fulfils the age-long objective of reducing the cost of fixed equipment to a minimum, so as to get the best return on investment whether the traffic is light or heavy. On a main-line scheme, the cost of fixed equipment may exceed that of the motive-power units; on a suburban railway, it will not be much less than it.

Although the electric locomotive for equal power is less than half the cost of its Diesel counterpart, a main-line 3300hp electric locomotive carries charges for interest and depreciation of about £7500 a year. So it is important to think of the efficiency of use like the efficiency of a motor or transformer, and to ask why figures are not of the same order. The target should be higher than 100000 miles/year, which is often accepted; 70m.p.h. × 8760 hours, i.e. over 600000 miles, is, of course, not practicable, but should we be content to get as little as 16%?

1 *A modern a.c. locomotive*

The fuel costs will not be greatly different whether Diesel or any kind of electric traction is used, but everything should be done to make a low tariff practicable. That proves to be another way of increasing the annual mileage of electric units by using the lines for freight working at night to the very maximum that is possible, so freeing our roads for driving for pleasure by day.

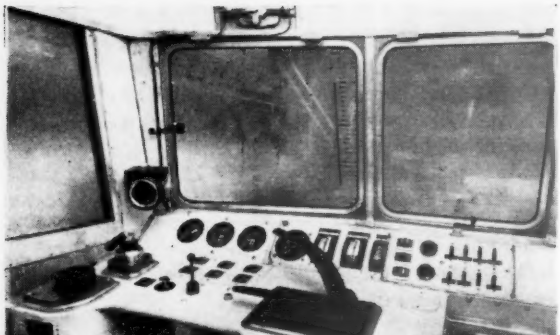
It is interesting to contrast the locomotive of 40 years ago in Great Britain with that of today. A locomotive was still in service in November 1960 that was built about 1914. It weighed 74 tons and had a maximum tractive effort of 28000lb and a continuous power of 1100hp. It cost about £5500.

Another locomotive, of which 40 are being built, is the most recent a.c. locomotive in this country (Fig. 1). It weighs 79 tons and has a maximum tractive effort of 48000lb, or nearly twice the earlier one, and a continuous power of 3200hp, or three times the other. This reflects the way the power/weight ratio has altered throughout the electrical industry in a generation. Unfortunately, it costs over £70000, or about 12 times the other, which reflects another familiar characteristic of modern life.

The 25kV 50c/s system

The choice of 25kV for the overhead contact wire is a value borrowed, like some other good things, including the basic idea of the pantograph, from the French Railways. It allows electric traction to share with the supply industry and the low-frequency railways the benefits of high voltage as the efficient way of transmitting power over a distance. It reduces the amount of copper and steel in the overhead wires and feeder system. By comparison with the former standard 1·5kV d.c., it reduces the over-all cost to the railway of getting power to the overhead contact line to about one-third of what it would be at 1·5kV d.c.

The fact that 25kV is not yet and may never be a suitable voltage for supplying the traction motors does



2 *Driving cab of locomotive*

not matter, as the locomotive needs a means of controlling its speed. Speed control is easily made by varying the voltage applied to the motors by many methods. British Railways chose to continue to use d.c. series motors. These motors have the kind of relation between speed and tractive effort that is needed. Transformers and rectifiers are used to convert from alternating to direct current; speed control is obtained by tapping on either the h.v. or the l.v. side of the transformer, so increasing the voltage to the motors as the train accelerates.

All this equipment takes up a lot of room, and there is very little room within the British Railways loading and below the structure gauges. On this fleet of 40 locomotives the roof is detachable—another idea borrowed from France—so that the equipment is easier to install and maintain. Either germanium or silicon semiconductor rectifiers are used. These are so much smaller than their predecessor, the mercury-arc rectifier—itself hardly born 40 years ago—that there is room, without increasing weight, for an air-blown resistance to act as a brake. This reduces wear of the brake blocks and so keeps the locomotive, which need not go back to shed for fuel or other attention, at work instead of going back to shed once a week for new brake blocks.

Even this locomotive is already out of date. For example, in the autumn of 1961 the first transductor-controlled locomotive started its trials. This is expected to be the harbinger of a future when solid-state devices will be used to control power and speed. These devices will take up less room and, having no moving parts, should be indestructible and cost much less to maintain. This is an example of the improvability of the 50c/s a.c. system.

Extent and type of equipment

In 1955, when the 50c/s system was chosen, there were only three motor coaches of a makeshift character and the experience of the Société Nationale des Chemins de Fer Français as a guide to what was possible. Today there are 385 motor coaches and 58 locomotives, with 126 more motor coaches and 42 more locomotives on order. A total of 681 miles of single track has been electrified on the new system, and work is authorized and in progress on 1833 more miles. Of this, 60% of the present and 86% of the whole is designed to work at 25kV.

The locomotives include a great deal of standardization, so that a driver need not normally distinguish between one kind and another. The driving cab (Fig. 2) is standardized, ample in size and not cluttered up with a mass of instruments and lights. The next fleet should contain even fewer gadgets. They are sources of weakness, as well as an indication that the equipment needs protection, whereas electric-motive-power units should have components that are suitable to their work. Their maintenance cost can and must be made much less than one-half that of the Diesel counterpart. Much attention has been paid to appearance design—all kinds look like brothers, although they inevitably lack the sentimental appeal of the steam locomotive. Their colour is typical of the cleanliness that is a real and valuable advantage of electric traction.

The achievement, not entirely successful, of putting nearly 300 three- and four-car multiple-unit trains (Fig. 3) on the road within four years in the full gaze of the public, after what has proved in some cases to be less than the desirable minimum of trial service, was a considerable one. Over 8 million multiple-unit train miles had been run by mid-May 1961, two-thirds of it since November 1960.

A lot has happened since the 5th November 1960, when

3 *Multiple-unit train, for use on Manchester–Crewe line*

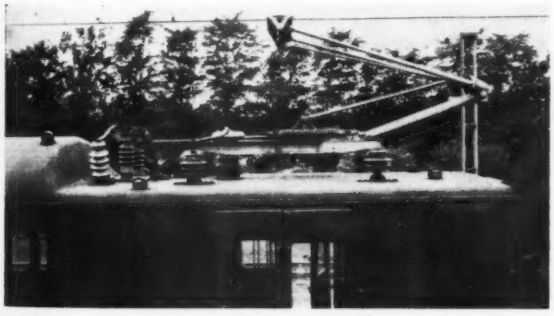
the Glasgow electrification was opened. On the 5th–7th November 1960 the Liverpool Street–Southend 1·5kV d.c. overhead electrification was converted for service on 6·25kV without a hitch; and on the 21st November 1960 the North-East London lines, Liverpool Street–Enfield–Chingford–Hertford and –Bishop's Stortford, were opened. The Manchester–Crewe suburban services have run successfully since September 1960.

Never again will it be necessary to introduce a full accelerated service on a given day after relatively restricted trials in steam timings. Now there are lines on which new equipments can be tried out in full service in good time.

In all these trains the power equipment is mounted below the floor, except the pantograph and the air circuit-breaker for which there is just, but only just, room over the guard's van (Fig. 4). No other 50c/s multiple-unit trains have yet achieved this formidable task of housing a substation on a coach without losing one fare-earning passenger-carrying seat. Because these trains handle commuter traffic, that is important.

The dual-voltage system

Technically, the most significant feature of British a.c. trains is that, because they run over old lines into main cities, it is not practicable yet to maintain 25kV throughout. So 39% of the line is electrified at 6·25kV on the Glasgow electrification, and 66% on the Eastern Region lines. Ground magnets, as shown in Fig. 5, are installed



4 *H.V. roof equipment with pantograph on a multiple-unit train*

at the beginning and end of the neutral section between overhead equipment energized at 25 and 6·25kV respectively. These magnets trigger off an automatic selection, check and changeover arrangement on the trains by which the windings are changed from four sections in series for 25kV to four in parallel for 6·25kV. Overlooking some minor troubles, much of the equipment has worked well, but in two cases serious complications have arisen.

Brig. C. A. Langley, Chief Inspecting Officer for Railways of the Ministry of Transport, is still inquiring into these. His first interim report was issued on the 13th January 1961*, less than a month after it had become

* Brig. Langley's second interim report was published on the 30th May 1961. His final report is still unpublished

5 *Automatic-power-control ground magnets (foreground)*

necessary temporarily to close the Glasgow electrification (on which traffic had been more than double what it was on steam) after a failure of five out of 68 transformers; modified trains with a different kind of transformer are now successfully undergoing trial running. On those Eastern Region trains that got into difficulties, it is well known that traction-motor failures developed. A cure for these was found fairly soon, but other modifications that were found to be necessary will be described in Brig. Langley's final report.

The largest fleet, however, of 112 four-car trains, destined ultimately for service on the London (Fenchurch Street)–Tilbury–Southend electrification, gave yeoman service on all parts of the Eastern Region during this difficult time. This equipment had had the longest trial running, three sets having been installed on the Lancaster–Morecambe line in 1952.

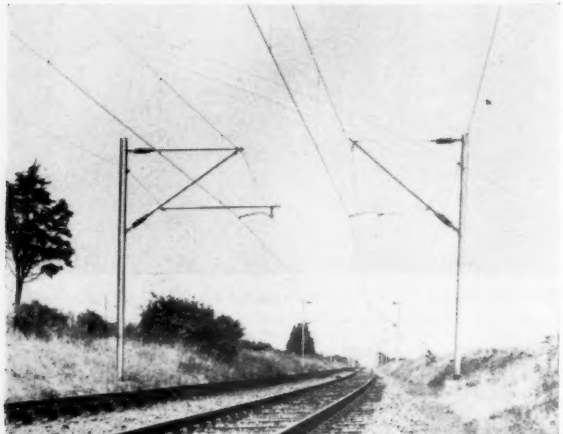
Rectifier developments

The substitution of semiconductor for mercury-arc rectifiers—provided that they are properly made, tested and graded and that sufficient are used—offers the advantage of freedom from gadgetry in the shape of exciters and heaters and so on, and so comes nearer to the specification of a self-supporting equipment.

The thoroughly reliable service given by such rectifiers used on the Manchester–Crewe trains may be mentioned. Also, excepting two easily avoidable difficulties, those installed on the 1·5kV d.c. train equipments of the Liverpool Street–Shenfield stock to convert from alternating current worked well. It was only in 1956 that British Railways could announce the first successful trial of a germanium rectifier on a multiple-unit train. The bold policy of ordering these others has been justified. And the days of the electro-pneumatic contactor, the mainstay of all former electrifications, may also be numbered.

An equipment will be put into trial service this year on which the transition from one step of voltage to the

next is made without breaking any of the main current on moving contacts. Even in the best contactors, some arcing must take place and maintenance is eventually needed—in this new equipment the electrons will move peaceably under what is effectively servomotor control.



6 *Overhead equipment*

Even the well-tried d.c. series motor is unlikely to be immune from these new electronic techniques: for the moment it is still supreme, with its major problem, commutation, an art rather than a science, but simpler ways of varying torque and speed are round the corner now that we are beginning to know how to control electrons.

Fixed equipment

The high cost of fixed equipment and the length of time it takes to put up, and the great inconvenience this operation causes to other railway departments and, for a time, to the travelling public itself, are the great disadvantages of electrification. Fig. 6 shows such overhead equipment.

Great strides have been made in the past five years, and much that was then good practice is now out of date. Fittings have been simplified in the interest of speed of erection, reliability and cost. Glass-fibre techniques should solve the most difficult problem of all, the maintenance of as near uniformity as possible in the dynamic properties of the overhead system, so as to ensure sparkless collection of current from the wire.

Increased knowledge arising from improved testing techniques should further reduce the cost of electrification, e.g. of avoiding interference with telecommunication and signalling circuits. With a few exceptions only, the use of return conductors, with or without booster transformers, to reduce interference at the source, though rather costly, being about 5% of the cost of the fixed equipment, has given freedom from complaints that many expected would arise.

Developments abroad, and other systems

The 660–750 V d.c. third-rail system on the Southern Region goes on from strength to strength within its own sphere. The unique London Underground system was built in the nick of time, mainly before the First World War. Here, electric traction was the only practicable form of motive power. The system has been extended, and other extensions are in hand or planned. What London's traffic would be like without it beggars description.

In France the 50c/s system continues to expand, with about 400 locomotives in regular service and prototype multiple-unit trains in service. Multiple-unit electric trains are to vie with the trans-Europe Diesels in the battle with air transport for speedy and comfortable travel between the capital cities of Europe. They will accept 15 kV 16⅔c/s, 25 kV 50c/s, and 1·5 and 3 kV d.c. supplies. In India the 50c/s 25 kV system is established as the new standard and is going ahead at a rate of 200 miles, soon to be 400 miles, a year. So also in China and in Russia, where the talk is of building 700 a.c. locomotives a year.

Even in the United States, where the Diesel has been supreme for main-line work for a generation, the question of electrification is being reconsidered. And in Los Angeles, where the motor-car has demanded about half the city for its road space and parking, the question of building a suburban railway is under active consideration.

Electric traction, in fact, is a way of earning a satisfactory return on capital and of giving the public the kind of service it wants and may reasonably demand, namely cleanliness, comfort and reliability. So it could bring the railways back into repute and earn far more than the net return an accountant might expect.

In countries not committed by their earlier investments, the 50c/s system is accepted today as the system of the future. It has the lowest cost for fixed equipment and has the greatest possibility of further simplification as research and development become actualities. Clearances can no doubt be reduced so that the 25 kV areas can be extended and perhaps the 6·25 kV areas increased to 12·5 kV, with advantage to all concerned. This is the exportable system; and, for the reasons given, it is an increasingly viable system for this country to use, although a price has been paid for doing many years' work in a few.

Summary

The adoption of the 25 kV/6·25 kV 50c/s single-phase system for the electrification of heavily trafficked lines as part of the British Railways modernization plan is fulfilling the objective of reducing the cost of fixed equipment to a minimum. Troubles with the new equipment have resulted from its rapid introduction to full public suburban services of great intensity with necessarily limited trials. Much of the equipment has performed well. Great advances in design and technique are being made in the equipment; and the 50c/s system, which is being widely adopted in other countries also, promises well for the future of electric traction.

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Electrical engineering at Stanford University

The author, King George VI Fellow at Stanford during 1958–59, has just received a Ph.D. degree from that university. As he emphasizes in this article, his experience must not be considered typical of American universities: more appropriately, it should be considered as indicative of the pattern of electrical engineering in American universities in the near future.

C. W. TURNER, PH.D., GRADUATE

STANFORD University, a privately endowed institution, situated some 40 miles south of San Francisco, is not a typical American university. Indeed, in its Electrical Engineering Department it is outstanding, not only in the generally high standard of academic endeavour, but in a number of additional features. Among these may be cited its location in the heart of a region of spectacularly rapid growth, particularly in the electronics and missile industries.

The remarkable partnership established between university and industry, plainly evident at Stanford, has played an important role in the development of facilities for postgraduate education. Local firms give the university energetic support and encourage employees to read for higher degrees on a part-time release basis. Stanford, in turn, provides a ready supply of well qualified personnel for industry; more importantly, it has created an unusual environment that has attracted to the area outstanding workers in the electronics field, as well as research-oriented private organizations.

Postgraduate investment

The more general nature of the education given to the American student in his high-school and undergraduate years effectively leaves specialization, as his British counterpart understands the word, to the late undergraduate and postgraduate phase of his academic career. For example, at Stanford 60% of all male undergraduate students go on to study for higher degrees. (This figure of 60% must be interpreted in the context of education in the United States. The standard of the American first degree is commonly about one year behind that of the British equivalent.)

This recognition or acceptance of first-degree work as being preparatory for more intense specialization, although not yet commonplace for the United States as a whole, is certainly indicative of future trends in American university education. In the past, it has been mandatory to complete studies beyond undergraduate level in the fields of law and medicine, in order to attain professionally qualified status. It seems likely that other disciplines, notably in the natural sciences and engineering, will assume a similar attitude in principle.

At this juncture, the British observer may well wonder how anyone, outside the supertax bracket, can afford to devote six or seven years to, say, an electrical engineering education. How, indeed! With many students supporting a wife, perhaps a family, and the inevitable automobile while reading for postgraduate degrees, the answer to this important question is illuminating.

First, summer employment is usually well paid, allowing a student to accumulate a solid financial foundation for the academic year. The fellowships, assistantships and research grants offered by private donors, as well as by the United States Government, are both numerous and generous. A large percentage of electrical engineering research programmes are Government sponsored, financing both the student and his research facilities.

Lastly, but most important, postgraduate students are encouraged and helped by the university itself. Married-student apartments, offered at low rents, are available at a number of the larger universities. Interest-free and low-interest loans from university funds, to be repaid within a specified time from the completion of studies, are commonly used by postgraduate students.

A further incentive of much importance is the recognition given to postgraduate training by industry, which rewards employees holding higher degrees, both financially and intellectually, with work of a suitably challenging nature.

In short, postgraduate education is looked upon by all concerned, student, university and industry, as a worthwhile investment.

General description

An evaluation, in British terms, of American undergraduate education is not only difficult but, in the opinion of many educators, has no basis and can only be misleading.

However, at postgraduate level in electrical engineering I feel that some useful and valid comparisons can be made. A description of curriculum material used at Stanford might, perhaps, provide an enlightening comparison and serve to illustrate that, at M.Sc. degree level, the electrical engineering student at the most distinguished American universities compares very favourably with, for example, a graduate member of The Institution.

Postgraduate study in the United States follows a formal pattern. Table 1 shows the requirements for the

three higher degrees offered at Stanford. Each 'course', so-called, generally comprises three 1-hour lectures per week for 10 weeks, the academic year being divided into three 10-week 'quarters'. These courses, examples of which are in Table 2, are completely self-contained, with regular problem assignments, mid-term examinations, and a final examination, on which a grade is determined. Candidates for higher degrees must complete the required number of courses with a satisfactory average grade. One can imagine that a keen sense of competition pervades even the realms of the postgraduate school, with, I must observe, distinctly successful results.

As elsewhere in the United States, the students are very highly motivated: there is much enthusiasm for tackling the more advanced aspects of electrical engineering. It is characteristic of the recent trends at Stanford to see electrical engineers attending lectures in quantum mechanics, real-variable theory, boundary-value problems, statistical mechanics and other topics formerly almost the exclusive concern of mathematicians and physicists.

Table 1. Requirements for postgraduate degrees (Student with B.Sc. degree)

M.Sc.	Engineer degree (intermediate between M.Sc. and Ph.D.)	Ph.D.
Candidates must take about 15 courses Degree is usually obtained in one year	Candidates must take about 20 courses. In addition, a thesis, usually practical in nature, must be submitted Degree is usually obtained in two years	Candidates usually take about 30 courses. Those with a superior average grade sit for a qualifying oral examination and a foreign-language examination. Successful students submit a thesis based on original research and complete the requirements by passing a final oral examination Degree is usually obtained in three to four years

Table 2. Examples of postgraduate courses in electrical engineering

Title of course	Texts used or applicable
Network synthesis	'Network synthesis' by D. F. Tuttle
Microwave measurements	'Microwave measurements' by E. L. Ginzton
Boundary-value problems in microwave theory	'Electromagnetic theory' by J. Stratton, and 'Field theory of guided waves' by R. E. Collin
Non-linear networks	'Introduction to non-linear analysis' by W. J. Cunningham
Maser theory	Lecture notes by A. Siegman
Statistical theory of communication	'An introduction to the theory of random signals and noise' by W. B. Davenport and W. L. Root
Microwave electronics	'Space-charge waves' by A. H. W. Beck
Semiconductor theory	'Electronic semiconductors' by E. Spenke

The series of electrical engineering courses chosen for the M.Sc. degree is usually broad in nature: the Ph.D. candidate aims to consolidate his theoretical background for his eventual research project and thus necessarily encounters more-advanced work than the M.Sc. candidate.

Research

In addition, the prospective Ph.D. student has to sit for an oral qualifying examination, complete a research project making a specific contribution to knowledge and a thesis thereon, and lastly pass a final oral examination.

This last phase of the Ph.D. programme is much more relaxed than the rather hectic period during which course requirements are being satisfied. At Stanford the projects are well supported financially, the services of technicians and machinists being made available to research students, who generally concern themselves with only the experimental and theoretical aspects of the project. It should be mentioned here that Stanford is particularly distinguished in its large number of postgraduate students—about 400 in all, of whom about 100 are Ph.D. students. The microwave laboratory alone accounts for about 50 research students.

Summary

My experience at Stanford as a postgraduate student has been an education within itself. I retain a strong impression of having observed part of a rapid transformation occurring in technological education in the United States. Consistent with their approach to undergraduate education, Americans have provided a strongly competitive environment for postgraduate study. Whether this is conducive to the original thinking one expects from students for higher degrees is open to debate.

In Britain, we have much to learn from the American experience of educating large numbers of the population, particularly in the technological field. At present, the better American universities, with whose graduates I have worked these last three years, are clearly demonstrating that specialization can well be delayed and yet not impair the training of technologists, provided that sufficient incentive is offered for students to pursue postgraduate education.

It is easy to point to the better economic conditions existing in the United States when acknowledging the superior training being offered to an increasing proportion of the student population at postgraduate level. At the same time, however generous the financial awards and opportunities may be, the motivation must be present also for years of further study demanding considerable application and concentration. This is perhaps the essential ingredient that the American student possesses: he knows where he is going and is prepared to invest in education to realize his chosen goal. The origins of his drive and ambition are, I suspect, to be found in the inherently competitive character of American life.

INSTITUTION COUNCIL MEETING ON THE 5th OCTOBER 1961

THE following summary of reports received and decisions reached by the Council of The Institution at their meeting on the 5th October 1961 is issued on the authority of the President in a form approved by the Council. It will be understood that this report does not purport to be a complete account of the matters discussed at the meeting, as some items are to be the subject of further discussion by the Council.

Constitution

In accordance with established custom, the retiring President formally introduced the incoming President, Mr. G. S. C. Lucas, O.B.E., F.C.G.I., and invited him to take the chair. When Mr. Lucas had done so, he moved a warm vote of thanks to Sir Hamish MacLaren for the very able manner in which he had presided over the meetings of the Council during the past session and for his work on behalf of The Institution; this was accorded unanimously.

On taking their seats for the first time, the new members of Council were received by the President, each coming forward in turn to shake hands with Mr. Lucas.

Committees for the 1961–62 Session

The Council agreed on the constitution of the Committees of Council and Special Committees for the 1961–62 Session, which will be found on p. 701.

Retiring members of Council and Committees

Resolutions that the best thanks of the Council be accorded to retiring members of Council for their services on the Council, and to those members of Council and others whose services on the Committees of the Council and on Special Committees had terminated on the 30th September 1961 for their services on these Committees, were passed unanimously.

Membership

The Council gave final confirmation of the election and transfer of those candidates whose names had been published with the August 1961 *Journal*, to become effective from the 2nd October 1961. Taking these into account, the total membership at that date was 48081.

Representation of The Institution on other bodies

On the recommendation of the General Purposes Committee, the Council approved a number of nominations of members as representatives of The Institution on other bodies. Details will appear in the *Journal* in due course.

The Institution Summer Meeting 1963

Invitations had been received from the Northern Ireland and North-Eastern Centres for the 1963 Summer Meeting to be held in their areas. The Council, having in mind that the Institution Summer Meeting had not previously been held in Northern Ireland, decided to accept with pleasure the invitation from the Northern Ireland Centre and to express their thanks to the North-Eastern Centre for their invitation, which they were sorry they were unable to accept on this occasion.

National Council for Quality and Reliability

In response to a proposal that The Institution should become a founder member of the National Council for Quality and Reliability, the Council agreed that The Institution should participate for one year in the first place, and to invite Dr. H. L. Haslegrave, M.A., M.SC.(ENG.), MEMBER, to serve as The Institution's representative.

The decision to establish this National Council had been taken at an exploratory meeting sponsored by the British Productivity Council, attended by representatives of a number of interested bodies, including Dr. Haslegrave, who had been asked to attend on behalf of The Institution.

Age-limit Graduates

The Council, on the recommendation of the Membership Committee, supported by the General Purposes Committee, agreed that any Graduate whose membership is terminated when he attains the age limit of 40 (because he has not held a post carrying the required responsibility to qualify for transfer to Associate Membership), who is subsequently approved for re-election as an Associate Member, shall, if he had paid three years' consecutive subscriptions during his membership as a Graduate, be entitled to pay the reduced entrance fee that he would have paid if his membership had not been terminated.

Institution Conversazione

The Institution Conversazione was held at the Royal Festival Hall in the alternate years 1956, 1958 and 1960; but, in an endeavour to assist in the phasing of major activities, the Council had agreed that the next occasion should be in 1963 instead of in 1962. It had since transpired, however, that in consequence of extensive rebuilding work at the Royal Festival Hall it would not be possible for the function to be held there in 1963 but a date—Thursday, 5th July—was available in 1962. In these circumstances, the Council decided that the next Conversazione should now be held on the 5th July 1962.

The new Divisional structure

In giving approval to the notice and schedule of proposed Bye-law changes and accompanying explanatory memorandum, to be sent to each Corporate member in connection with the Special General Meeting on the 2nd November 1961, a general feeling was expressed that a more appropriate title should be found for the 'Electrical Science and General' Division (September 1961 *Journal*, p. 553). The Council agreed that further consideration should be given to this question and decided in the meantime to refer to this Division as the 'Science and General' Division, omitting the word 'electrical'.

Committee on Higher Education

At their meeting on the 22nd June 1961 (see July 1961 *Journal*, p. 433), the Council had accepted a recommendation of the Education and Training Committee that evidence should be submitted to the Committee on Higher Education, set up under the chairmanship of Lord Robbins to review the pattern of full-time education in Great Britain.

Mr. S. E. Goodall, on behalf of the Education and Training Committee, now presented for the Council's consideration a draft memorandum and reported that the Joint Advisory Committee on Engineering Education had recommended that a joint memorandum should be submitted on behalf of the three Institutions.

After a full discussion, during which a number of points were raised, the Council decided to ask the Education and Training Committee to give further consideration to the memorandum in the light of the discussion that had taken place, so that the document eventually submitted would be of the highest possible value to the Committee on Higher Education.

Wiring Regulations

Mr. Forbes Jackson, Chairman of the Wiring Regulations Committee, requested authority for the publication of 1961 Amendments to the 13th Edition of the Wiring Regulations. This the Council gave, and they also authorized the Wiring Regulations Committee to proceed with the preparation of a 14th Edition of the Regulations (see p. 648).

RAPID PROGRESS IN MICROWAVE MEASUREMENT

Conference on microwave measurement techniques, 6th–8th September 1961

A conference on microwave measurement techniques was held at Savoy Place on the 6th–8th September 1961. The conference was organized by the Electronics and Communications Section and was attended by 380 delegates, many from oversea. Two sessions were held on each of the three days.

The first session was opened by the then Chairman of the Electronics and Communications Section, Mr. T. B. D. Terroni. After welcoming the participants Mr. Terroni explained that the Electronics and Communications Section had felt that a conference of this kind was now timely and desirable.

In an introductory lecture at the first session, Prof. H. E. M. Barlow discussed the reasons for giving special consideration to measurement techniques in the microwave-frequency region, pointing out that microwaves occupied a unique place in the r.f. spectrum in being susceptible to electrical rather than optical treatment, while still requiring techniques completely different from those used at lower frequencies. After reviewing some of the fundamental concepts essential in microwave engineering, Prof. Barlow outlined some recent major advances. He paid particular attention to the great use made today of ferrite isolators, circulators and modulators.

The standing-wave indicator was still a valuable instrument but was not now by any means the only useful technique for the measurement of impedance, even when precision measurements had to be made. Bridge circuits in particular, as well as the use of directional couplers, had proved their value in this respect. Prof. Barlow referred to the many applications now made of the perturbation technique, both in measuring fields within cavities and waveguides and in measuring free-space fields.

Precision and power measurement

The second session began with an introductory lecture by Prof. H. M. Altschuler of Brooklyn Polytechnic Institute on 'Precision measurement of microwave networks'. Precision measurement implied a procedure of measurement and analysis that resulted in error limits being specified with confidence. Precision measurements involved the appropriate averaging of a large number of data points. Ideally, the functional forms of the data loci were known, and the problem was to abstract their unknown parameters by relating them to the experimentally obtained points.

A technique for improving on first-order curves by successive approximations was proposed and illustrated in relation to the circular input reflection-coefficient locus on a lossy two-port device terminated by a variable reactance. A method of standard statistical-curve-fitting was extremely laborious in such a case, while the proposed method could be applied in a relatively simple manner. Similar techniques had been applied to tangent-relation loci as well as to circular loci. Finally, it was shown that auxiliary structures, such as lossy variable terminations, might sometimes be used with advantage to increase the accuracy of certain measurements.

The third session was opened by a lecture on 'Microwave power measurement' by Prof. A. L. Cullen. A brief review of the physical phenomena that might be used as the basis of microwave-power-measurement techniques was given, followed by a description of typical instruments. It was emphasized that accuracy was by no means the only criterion in selecting a microwave wattmeter. Other factors, such as response time, might actually be decisive.

Consideration was given to the scaling laws of different types of wattmeter, having in mind particularly the possibility of application to millimetric and submillimetric wavelengths. Finally, some attention was paid to possible future developments, and one or two lines along which future work might proceed were suggested.

Measurements in microstrip

The fourth session began with a paper by Messrs. L. Lewin and G. H. B. Thompson on 'Measurements in microstrip'. The paper was presented by Mr. Lewin as an introductory lecture to the session and described some of the problems in this field. It was emphasized that there was a difference at the outset in dealing with microstrip systems in that the basic propagation characteristic had not yet been analysed and the usual assumption of TEM-mode propagation, though often adequate in practice, was wrong in principle.

It had not been found possible to adapt instruments such as the waveguide standing-wave indicator for use with microstrip. Instead, a transition from microstrip to a waveguide or coaxial-line standing-wave indicator was usually made, but this entailed due allowance for the mismatch at the transition between the standing-wave indicator and the microstrip. Some of the practical and theoretical considerations relating to such measurements were discussed.

The effect of radiation at discontinuities was described,

and techniques were suggested for reducing the undesirable effects of radiation. Mr. Lewin stressed that measurements in microstrip were in nothing like the same condition of accuracy or maturity as similar measurements in more-orthodox transmission media. There was clearly much work to be done, and some of the more important areas of research were indicated.

Electrical properties of materials

The last session, though dealing mainly with special techniques for the measurement of electrical properties of materials, opened with a more general introductory lecture by Mr. I. A. Harris on 'Errors and uncertainties in microwave measurements'. A brief statement of the conditions for fundamental measurement was first made.

The basic philosophy underlying the concepts of 'true values', 'measured values' and 'errors' was explained and illustrated by a consideration of methods for setting out standard scales of power level and attenuation. Emphasis was placed on coaxial-line apparatus, since the need for improvement in accuracy was greater in coaxial systems than in waveguide systems. It was emphasized that there was a great need for improvement in the accepted v.s.w.r. values in both coaxial and waveguide systems for high-grade measuring apparatus.

Discussion and exhibition

In all the sessions, some time was set aside for discussion, and although the speakers, appropriately influenced by their chairmen, kept fairly well to their allotted times in presenting their papers, there was still not enough time left for really adequate discussion. One or two points of nomenclature and usage were raised. Early in the conference, Mr. Lewin pointed out that it was meaningless to speak of a large v.s.w.r. without saying whether the ratio referred to was V_{min}/V_{max} or V_{max}/V_{min}. Lack of standardization in this respect had already led to one brief misunderstanding in the conference.

A second point concerned the accuracy of reflection-coefficient measurement. If, for example, it was stated that a reflection coefficient of 10% was measured to an accuracy within 1%, did this mean that the reflection coefficient could be stated as $0{\cdot}10 \pm 0{\cdot}01$ or as $0{\cdot}1000 \pm 0{\cdot}0001$? Either interpretation apparently was valid. Again, the quoting of error limits led to such statements as 'power was measured to an accuracy of 1%' or to such even more ambiguous statements as 'accuracy was not very great' and to the question 'is an accuracy of 1% greater or less than an accuracy of 2%?'!

The discussion added very materially to the value of the conference, and a great many useful suggestions and comments were made by the various speakers.

Another feature of the conference was the exhibition of microwave measuring instruments. This covered a wide range of measurement techniques over the whole of the microwave band to wavelengths as short as 2mm.

Aims fulfilled

Prof. Barlow concluded his introductory lecture with these words: 'The techniques of microwave measurement have progressed very rapidly in recent years, and to keep in touch with their many different aspects is no easy task. The present conference will, it is hoped, prove of particular value in this respect, calling attention to new developments while emphasizing potentialities and limitations of the techniques discussed'. There is no doubt that the aims of the conference were largely fulfilled.

A. L. CULLEN

C.E.P.T. AT TORQUAY

The Conference of European Postal and Telecommunication Administrations (C.E.P.T.) met at Torquay from the 11th to 22nd September 1961. Representatives of each of the 19 member countries—Austria, Belgium, Denmark, Finland, France, Federal Republic of Germany, Greece, Iceland, Republic of Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey and United Kingdom—were present. This was the second annual meeting of the Conference, which was set up in 1959 to examine ways of improving postal and telecommunication services in Europe and to facilitate collaboration in these spheres.

In the telecommunication field, the Conference concerned itself with a wide range of technical, operational and financial questions concerning telecommunication services between member countries of C.E.P.T. and also between member countries of C.E.P.T. and the rest of the world. An interesting development was the establishment of a new study group, under the chairmanship of Capt. C. F. Booth, Deputy Engineer-in-Chief of the British Post Office, to consider the problems that will arise as developments proceed in the new field of radiocommunication via artificial satellites.

Other telecommunication matters that continue under study included the possible establishment of European switching centres for intercontinental telephone and telex traffic, the provision of a permanent network for the interchange of television programmes between European countries, co-ordination within the C.E.P.T. countries in matters relating to radio interference from scientific, medical and industrial equipment, the possible development within Europe of an international v.h.f. radiotelephone system for communication between vehicles and base stations, and 'one-way calling' (paging) systems for individuals as well as vehicles.

B.C.A.C. ANNUAL GENERAL MEETING

At the first Annual General Meeting of the British Conference on Automation and Computation held at Savoy Place on the 27th September 1961, the Chairman, Sir Walter Puckey, recalled that some 12 months ago the B.C.A.C. had been reconstituted in its present form. As required by the constitution, the meeting elected the honorary officers and executive committee for the ensuing year. The honorary officers elected were Sir Walter Puckey, Chairman; Mr. J. F. Coales, Vice-Chairman; Prof. G. D. S. MacLellan, Vice-Chairman; Mr. C. Mead, Vice-Chairman; Mr. S. M. Rix, Honorary Treasurer; and Mr. F. Jervis Smith, Honorary Secretary.

Thanks were expressed to the President and Council of The Institution for The Institution's help in providing secretarial services throughout the past year. A special vote of thanks was accorded to Mr. W. K. Brasher for his work as Honorary Secretary, and the appointment of Mr. F. Jervis Smith, Deputy Secretary of The Institution, as his successor was welcomed.

LETTERS TO THE EDITOR

Watts and vars.....Prof. R. O. Kapp, B.SC.(ENG.), MEMBER
Co-operation with Europe ....Prof. E. W. Marchant, D.SC., F.C.G.I., PAST-PRESIDENT, HONORARY MEMBER
Rule of thumb and fingers .....M. Ouyang, B.ENG., PH.D., ASSOCIATE MEMBER

WATTS AND VARS

Dear Sir—Two contributors to this correspondence support the view of the International Organization for Standardization (I.S.O.) that one var equals one watt, seven reject it. Those who support the I.S.O. reveal a misconception of the meaning of the technical term 'reactive power' and its unit, the var. They seem to believe that reactive power is the product of the voltage in a reactor and the current that flows in the reactor *at the same moment of time*. It is not. This quantity is not called reactive power and is not measured in vars, even if it occurs in a reactor or a capacitor. It is called power and is measured in watts.

Reactive power is obtained by taking the product of two quantities that occur at different instants of time. In a 50c/s system these instants are separated by 1/200th of a second. When one multiplies a voltage that occurs at one instant of time by a current that occurs at another instant, the product is not a rate of change of energy, and I doubt whether any of the conflicting theories of dimensions could provide proof that a quantity that is not a rate of change of energy has, nevertheless, the dimensions of power.

This argument is implicit in the contributions from many of your correspondents, but Mr. B. B. Jacobsen (October 1961 *Journal*, p. 604) comes nearest to removing the misconception. Let me repeat a little from his letter.

Let the instantaneous value of a sinusoidally varying voltage be $v = \sqrt{2}V \sin \omega t$ and the instantaneous value of the current at the same moment of time be $i = \sqrt{2}I \sin (\omega t + \phi)$, where V and I are root-mean-square values. The product is:

$$vi = VI(\cos \phi - \cos \phi \cos 2\omega t + \sin \phi \sin 2\omega t)$$

This shows that a constant power, $VI \cos \phi$, which does not vary with time, is superimposed on an oscillating power that changes from moment to moment.

It remains only to amplify Mr. Jacobsen's exposition. Let the instantaneous voltage v be multiplied by a current i', which occurs one quarter-cycle earlier than v. Then:

$$i' = \sqrt{2}I \sin (\omega t + \phi - \pi/2)$$

and it is easy to show that:

$$vi' = VI(\sin \phi - \sin \phi \cos 2\omega t - \cos \phi \sin 2\omega t)$$

A synonym for reactive power is wattless power. The term is linguistically ill-chosen but technically informative. The fact that reactive power is obtained by multiplying two quantities that occur at different moments of time is implicit in the design of reactive-power meters. These instruments incorporate a magnetic storing device such that the effect of one of the elements on the moving parts is delayed by a quarter-cycle.

To those unfamiliar with electrical power engineering, reactive power and its unit the var may seem very artificial concepts. But they do not appear so to those who are familiar with phase displacement, and to whom the phase angle between current and voltage is of decisive importance in the design of plant and apparatus. It may be difficult to find a place in a system of scientific concepts for the product of two quantities that occur at different instants of time, but one cannot deny physical reality to this product. It operates a measuring instrument. Its time-integral, measured in var-hours, is a commodity that is bought and sold in the electricity supply industry.—Yours faithfully,

REGINALD O. KAPP
Kennedy and Donkin
12 Caxton Street
London S.W.1

16th October 1961

CO-OPERATION WITH EUROPE

Dear Sir—I have read with interest the Foreword in the September 1961 *Journal*, p. 537, on co-operation with Europe.

I cannot agree that the decision whether we and the Outer Seven eventually join The Six will determine for many years to come the form of development of science and technology in Great Britain.

Looking back over the last 60 years I am impressed by the tremendous influence of individual discoveries. It was J. J. Thomson who first proved the existence of particles smaller than the atom, which enabled Rutherford to put forward his theory of atomic structure.

These discoveries were the starting-point of modern physical science and have influenced the course of research in every country of the world. Conferences attended by the presidents and permanent secretaries of engineering institutions have their uses, but can anyone point to a major step in the development of science and technology that has been due to their activities?—Yours very truly,

E. W. MARCHANT
Brook Farm
Grendon
Atherstone, Warwickshire

21st September 1961

RULE OF THUMB AND FINGERS

Dear Sir—The author of a most stimulating textbook on the fundamentals of electromagnetism remarks that the engineer should have a simple working rule whereby he can obtain the relative directions of the magnetic field, the motion of the conductor, and the electric current (or e.m.f.) in a motor (or generator). He includes Fleming's rules in his book. There are several methods by which these rules can be

memorized with ease, but these methods always rely on some alphabetic associations. And there is still the need to remember which hand to use!

When teaching in a country where lectures are given in a non-alphabetic language, I could not resort to the alphabetic tricks. Fortunately, the circumstances favoured the introduction of a new rule, which can be easily remembered in any language. The circumstances were these. In that country, writing with the left hand was, and I believe still is, considered not merely unorthodox but downright wrong. The complete rule is as follows:

(1) Always use the left hand (which is supposed to be idle during the examination anyway)
(2) Extend the three relevant fingers in the way Fleming wanted, so that they point in three mutually perpendicular directions
(3) Consider the fingers in the sequence: thumb, index finger, middle finger. (For thousands of miles around, a raised thumb is a gesture meaning 'the best'. The sequence is therefore natural.)
(4) The magnetic field, the motion of the conductor, and the current (or e.m.f.) then correspond to these three fingers in the sequence in which the physical entities are brought into being—for motors: field, current, motion; for generators: field, motion, e.m.f.

Students memorized this rule without any apparent effort. This may be because memorizing is made easier by logical association.

My apology to those who write with their left hands. Working to my rule, they have to down their writing tools not only when motors are concerned.—Yours faithfully,

M. OUYANG
c/o E.R.A. Laboratory
Cleeve Road
5th October 1961 Leatherhead, Surrey

Nuclear-electronics symposium

THE Measurement and Control Section, in conjunction with the British Nuclear Energy Conference, is arranging a symposium on nuclear electronics, to be held at Savoy Place on the 30th November and 1st December 1961. The International Atomic Energy Agency held a conference on the same subject at Belgrade in May 1961. The Institution's symposium will enable those who did not attend the Belgrade conference to hear and discuss reports on the matter presented there. The three sessions of the symposium will deal with radiation detectors, electronic circuits and techniques, and radiation monitors and instruments. There will be a cocktail party at Savoy Place immediately after the first session.

The programme for the symposium is given below.

THURSDAY, 30TH NOVEMBER

5 p.m. Session 1—**Radiation detectors**

Report on Belgrade conference by W. Abson, B.SC.
Improved scintillation counters by Prof. J. B. Birks, B.A., PH.D., D.SC.
Image intensifiers and scintillation-track imaging by R. B. Owen, B.SC.
Semiconductor radiation detectors by G. Dearnaley, M.A., PH.D.

FRIDAY, 1ST DECEMBER

11 a.m. Session 2—**Electronic circuits and techniques**

Report on Belgrade conference by K. Kandiah, M.A., B.SC.
Ultra-high-speed oscillographic techniques by S. D. Abercrombie
Equipment for fast-neutron time-of-flight spectroscopy by P. R. Orman, B.SC., PH.D.
Data-handling equipment by B. Collinge, B.SC., PH.D.

3 p.m. Session 3—**Radiation monitors and instruments**

Report on Belgrade conference by D. Taylor, M.SC., PH.D.
Plutonium monitors by D. E. Barnes, O.B.E., G.M., B.SC.
Dr. Borkowski's personal monitor by D. S. Hiorns, B.SC.(ENG.)
Health-physics instrumentation for nuclear power stations by G. C. Dale, B.SC.

SETS conference 1961

THE Scottish Electrical Training Scheme held its 5th annual conference in Edinburgh on the 29th September 1961. As previous conferences, it took the form of a visit to the works of one of its members, Bruce Peebles and Co. There were 37 graduates and 80 vacation trainees present—appreciably more than at any previous conference. They visited the firm's engineers at work, in parties of about a dozen; this proved much more interesting and certainly more valuable than visits to the factory floor.

A luncheon was given at Leith Town Hall by the directors of SETS to the trainees attending. In a speech after the lunch, Mr. J. S. Hastie, chairman of the board of directors of SETS, pointed out that this was by far the largest of the five conferences held since SETS was established and that it showed a remarkable growth of this pioneer enterprise. He gave a special welcome to Prof. J. Lamb, who had just taken up the appointment of Professor of Electrical Engineering at Glasgow University.

Advanced courses

Mr. J. E. C. McCandlish, Organizing Secretary of SETS, said that the year had shown an intake of 21 graduates, while 106 men had been given vacation training, the highest figures ever. Because Scotland needed a proportion of graduates who carried their academic education further than the degree course, SETS was planning to start, in a year's time, courses of combined academic and industrially-based tutorial training in advanced mathematics, science and electrical engineering. These courses would be voluntary and progressive; most of the effort would be required from the graduates themselves in their own time. SETS was planning to arrange the lectures, probably at universities or senior technical colleges, coupled with tutorial work under the supervision of electrical engineers from members' staffs.

As a first step, SETS had approved the applications of 11 graduates to attend the advanced technical mathematics course at Heriot-Watt College this winter.

Mr. McCandlish wanted to encourage students to take up as many and as wide interests as they could. They would be the gainers, both as electrical engineers and as men.

U.R.S.I. symposium on space-communication research

Paris, 18th–22nd September 1961

In Paris on the 18th–22nd September 1961, the Union Radio Scientifique Internationale (U.R.S.I.) arranged a symposium on space-communication research. This is a brief report of the highlights of the symposium, at which 34 papers were presented.

THE symposium, which was held at the headquarters of the French Posts and Telecommunications Administration, was attended by some 170 delegates and observers from many countries.

At the first session it was pointed out that, although propagation to and from satellites involved no major unknown phenomena, much statistical information was needed, from a wide variety of ground locations, on the variation of absorption and noise-temperature in the troposphere with time, elevation and frequency. Low-elevation beam bending and reduction of aerial gain also required examination. Improved ground-aerial systems giving smaller side-lobe response and lower noise-temperature were worthy of study. By means of radio-telemetry, more long-term statistical data should be obtained on the space environment, particularly on the levels of radiation and micrometeorite bombardment liable to damage electronic equipment or the satellite structure. Information was lacking on the change of the space environment with time and on the effects of solar, or more distant, outbursts.

Satellite attitude

The control of satellite attitude and the maintenance of the relative positions of satellites within a group were recognized as being of considerable importance. Both active and passive systems were considered for attitude control; the former involved the carrying of fuel for correction jets, while the latter depended on the employment of such natural forces as that producing a differential-gravity torque on a suitably dimensioned structure. For station-keeping, the only alternative to extremely accurate orbit injection was the provision of correction jets operated by ground command.

The problem of the allocation of frequencies for space communication could be resolved only by international agreement. Some degree of frequency-sharing with ground services appeared to be inevitable, particularly in the light of the radio-frequency requirements inherent in the wide-deviation f.m. and p.c.m. systems likely to be essential for the early experimental and operational systems. These considerations lead to the necessity for further research into, for example, modulation systems approaching the ideal efficiency postulated by information theory, and tropospheric propagation phenomena when one or both of a pair of aerials have beams at small angles of elevation.

At present, the choice of modulation methods appears to lie between digital techniques and frequency modulation of large index, together with receivers having f.m. feedback.

Ground-station equipment

The session on ground-station equipment was devoted almost exclusively to aerial systems of high gain and low noise-temperature and to maser amplifiers. Several aerials of large aperture and high mechanical stability were discussed, and it became apparent that multiple-reflector structures (e.g. Cassegrain arrangements) showed considerable promise and merited extensive research and development. Multiple-cavity masers were capable of rivalling the travelling-wave device in gain and bandwidth, though not, perhaps, in noise-temperature.

Much research effort was being devoted to achieving reliability in electronic components for satellite equipment, involving design for, and testing in, the conditions obtaining during the pre-launch, launch and orbit phases. Papers related recent work, and the results gave rise to optimism.

The principal experimental communication systems now being sponsored in the United States by the National Aeronautics and Space Administration were described. They include Rebound (multiple passive reflectors), Relay and TSX (active transponders at medium altitude) and Syncom (active transponder at synchronous-orbit altitude). There was discussion on the relative merits of intermediate-altitude station-keeping satellite systems and those employing lower-altitude satellites in random relative position.

West Ford project

A paper on the West Ford experimental project, which involves the use of a belt of orbiting dipoles resonant at about 8 Gc/s, provoked a lively discussion and drew the special attention of optical, radio and radar astronomers concerned about the risk of deleterious effects on their particular disciplines. It was clear that more theoretical work was needed before the effects could be assessed of dipole belts denser than that now envisaged for experimental purposes.

Though the synchronous-orbit satellite system has attractive features for some applications, the effect of long transmission delay—amounting to over half a second for transmission to the antipodes—may be serious for commercial telephony. The results of various experiments designed to assess the effects of delay were described, but it was generally agreed that only after a large number of statistical subjective tests have been carried out will it become possible for the C.C.I.T.T. to recommend what is acceptable.

In conclusion, the symposium was wholly successful in defining those areas of radio research that remain to be explored before operational communication-satellite systems become practicable. It also served as a most useful forum for both formal and informal discussion between members of a representative cross-section of scientists and engineers closely engaged on furthering the development of such systems.

F. J. D. TAYLOR

The articles in this regular monthly feature are based on current papers read at Institution meetings. They are written by the authors of the papers, who have been asked to make the articles, so far as possible, interesting and of appeal to electrical engineers who have no specialized knowledge of the topics discussed. While the articles bring out the main points and conclusions of the papers, their contents are not necessarily confined to the subject-matter of the original papers

THE DESIGN OF POWER TRANSFORMERS BY DIGITAL COMPUTER

A short review of a Graduate and Student Section paper with the above title by A. C. Hall, Graduate. The paper was read before the North-Eastern Graduate and Student Section on the 15th January at Newcastle upon Tyne and on the 20th January 1960 at Sunderland. The paper was awarded a premium by the Council. The author is with C. A. Parsons and Co. Ltd.

THE facility of the electronic digital computer for high-speed computation has led to its application to a variety of problems requiring a large amount of hand computation. One such application is to design power transformers automatically, with as little intervention from the operator as possible. This has necessitated the assembly of a computer programme to include not only those instructions needed to perform the arithmetic calculations normally employed in transformer design, but also those required to make the logical decisions that form part of the design philosophy used by the design engineer in his work.

Hand-computation method

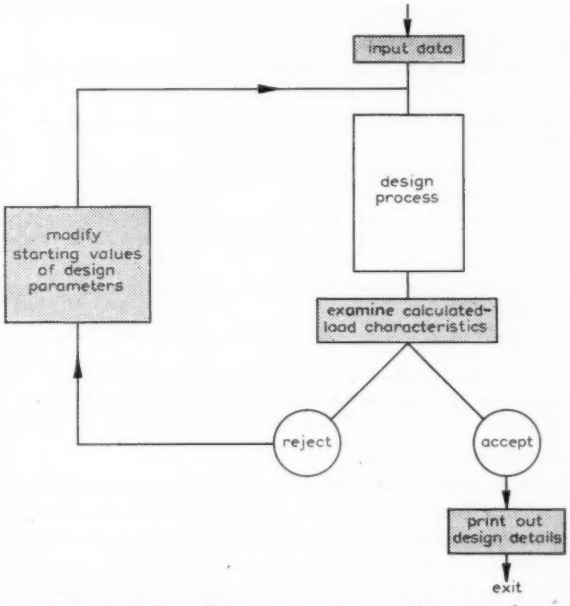
Examination of the existing hand-computation method of designing power transformers has shown it to consist essentially of two parts—first, a process of calculation based on established formulas and techniques to determine the load characteristics and performance of the transformer from initial data; and, secondly, a process to determine the modifications to be made to the initial data for the design to converge to one that will conform to the physical dimensions and performance required by the customer's specification.

Further examination has shown that the independent design parameters employed in the process of calculation are common also to the process of convergence, and it is on the basis of these parameters that the successful application of the computer to this work has been possible.

Design by digital computer

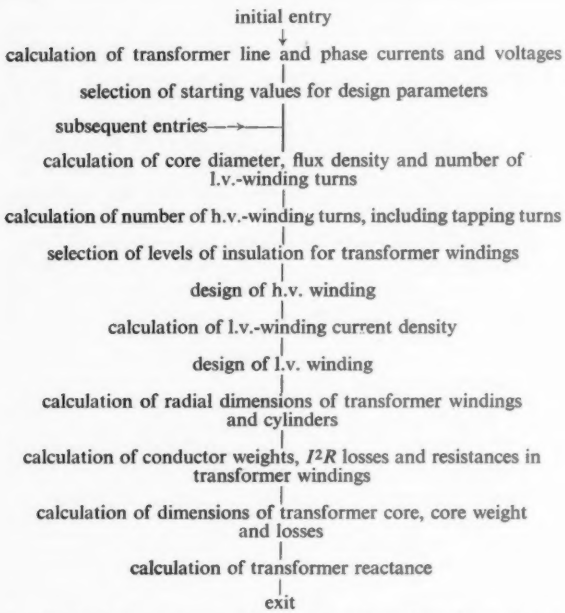
The diagram shown in Fig. 1 illustrates the complete transformer-design programme for a medium-sized digital computer. This programme can be considered to consist of two programmes in parallel; the first, the design programme, is confined to performing the calculations of the design process, while the second, the master programme, is responsible for controlling the operation of the computer and the design programme when the design is in progress.

The calculations employed in the design process (Fig. 2) are similar to those used by the design engineer when using hand-computation methods. As these are common to more than one type of transformer, the practice generally adopted has been to subdivide these calculations into subroutines and to programme them separately, so that those that are frequently used in the design of other types of transformer are available for inclusion in programmes assembled for that purpose.



1 *Simplified flow diagram for the complete transformer programme*
Functions that are tinted represent the master programme

Fig. 2 shows a typical arrangement of the separate subroutines for a design programme to produce a fully detailed design for a two-winding transformer. The ability of this arrangement to produce designs for a wide range of transformers is restricted only by the scope of the winding subroutines. This difficulty may be overcome by using a series of separate winding subroutines, one for each particular type


initial entry
calculation of transformer line and phase currents and voltages
selection of starting values for design parameters
subsequent entries
calculation of core diameter, flux density and number of l.v.-winding turns
calculation of number of h.v.-winding turns, including tapping turns
selection of levels of insulation for transformer windings
design of h.v. winding
calculation of l.v.-winding current density
design of l.v. winding
calculation of radial dimensions of transformer windings and cylinders
calculation of conductor weights, I^2R losses and resistances in transformer windings
calculation of dimensions of transformer core, core weight and losses
calculation of transformer reactance
exit

2 *Typical arrangement of separate subroutines for a design programme*

A fully detailed design for a two-winding transformer is to be produced

of winding, and inserting the appropriate subroutine into the design programme at the start of the design.

Subroutines

Many of the subroutines in the design process are essentially confined to arithmetic calculations, and these have presented little complication to the programming engineer. Others, however, require data that are normally supplied by the design engineer from previous designs of similar transformers or from his experience. On the computer, it is necessary for such data to be stored permanently in the programme and to be selected automatically when required.

Subroutines for the selection of starting values for the design parameters and levels of insulation for the transformer windings have been developed so that these data may be selected automatically by the computer in terms of the design constants, the apparent-power rating, line voltages, impulse level and core-leg diameter. Other data normally used in transformer design in the form of curves or tables have been reduced to simple equations in terms of their respective independent variables. By this means, it has been possible to reduce the quantity of input data required for the computer to start a design and to afford the design engineer greater flexibility when using the computer.

The subroutines, although arranged in sequence, operate independently of one another. The data for each subroutine are prepared by the master programme and placed in the computing store, from which they are used by the subroutine as required. On exit from the subroutine, the answers are transferred to the main store by the master programme and are retained there until a further iteration or a new design is started.

Other duties

In addition to these duties, the master programme performs those shown in Fig. 3. These include:

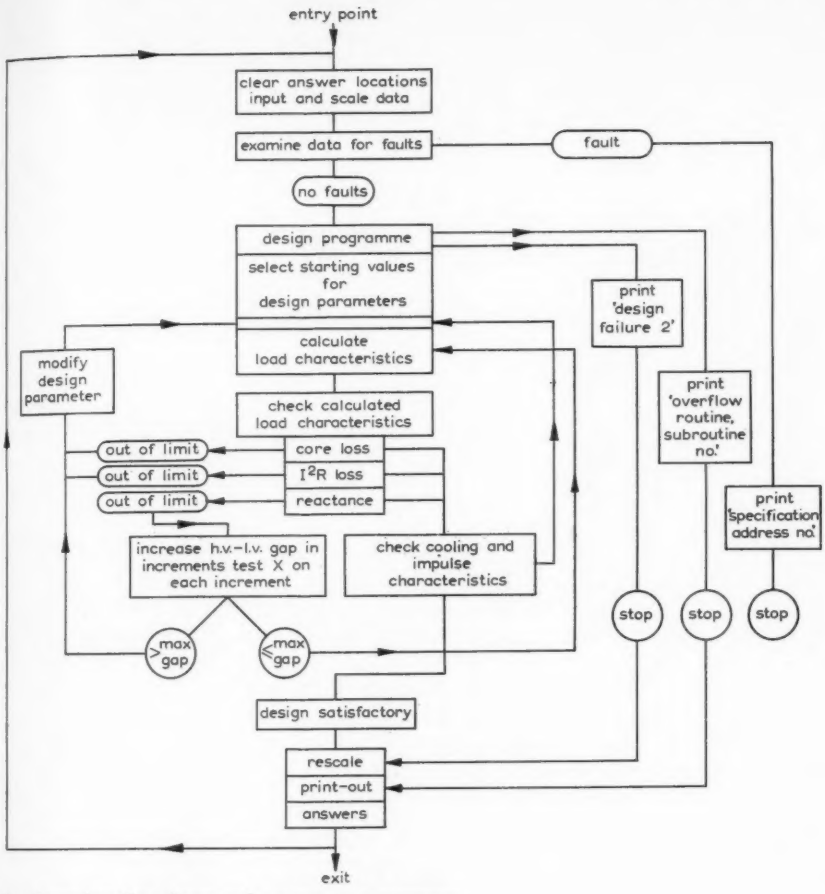
1. Reading into the computer, scaling and checking the data required to design the transformer
2. Testing the cooling properties and impulse characteristics of the designed windings
3. Comparing the calculated and desired load characteristics and performance
4. Making adjustments to the values of the design parameters
5. Taking action in the event of programme failure at any stage during the design
6. Rescaling and printing out the design details.

Each duty is designed to reduce the need for intervention by the computer operator while the design is in progress, and includes many of the operations performed by the design engineer when using hand-computation methods. This has meant ensuring that the master programme is sufficiently comprehensive and versatile to be fully automatic and to give the operator as much indication as possible that the design is proceeding satisfactorily without the need to cease computation. Every use has been made of such facilities as are available on the computer to indicate each stage of the design process as it is performed.

Action in the event of failure

In the event of failure of the design, the master programme causes the computer to show, either on print-out or by use of its visual-aids panel, the exact location, nature and cause of the fault. The operator may then take whatever action is necessary to clear the fault and restart the design by re-entry to the master programme at some known location. Automatic fault-location subroutines are included in the master programme for this purpose, together with facilities for the operator to intervene at any stage of the design and countermand decisions made by the computer, if this should be desired, by superimposing new instructions.

The use of a comprehensive master programme ensures that the operation of the complete transformer-design programme on the computer is straightforward and entails only the operator in preparing the computer, in observing that the computer having commenced to obey the programme instruction operates correctly, and finally in removing the answers



3 *Complete flow diagram for a master programme*

from the print-out device before preparing the computer for the next design.

Conclusions

The value and importance to the design engineer of a programme that can design transformers automatically are restricted only by the success with which these programmes can be prepared. Experience has shown that transformer design philosophy can be successfully programmed for use on a digital computer and that the range of transformer sizes covered by such programmes is restricted only by the scope of the individual subroutines.

The primary objective of an automatic technique of designing transformers has been adequately realized, and the actual designs produced are comparable to those obtained when using hand-computation methods. These programmes, together with the speed and accuracy of the computer, provide an efficient tool for use by the design engineer in his work. 621.314.2:681.142

MAGNETOHYDRODYNAMIC POWER GENERATION

A brief article based on a Graduate and Student Section paper with the above title by R. Hawley, B.Sc., Graduate. The paper, which was the Chairman's Address for the 1960–61 Session, was read before the North-Eastern Graduate and Student Section at Newcastle upon Tyne on the 7th October, at Carlisle on the 12th October and at Sunderland on the 18th October 1960. The paper was awarded a premium by the Council. The author was formerly in the Department of Electrical Engineering, King's College, Newcastle upon Tyne, and is now with C. A. Parsons and Co. Ltd.

RENEWED interest has recently been shown in the development of direct methods of producing electrical energy from chemical and nuclear fuels. Possibilities include the use of thermoelectric devices, thermionic generators and fuel cells. The most promising, however, seems to be the generation of electricity from ionized moving gases, a process that has become known as magnetohydrodynamic (m.h.d.) generation.

Conventional generator

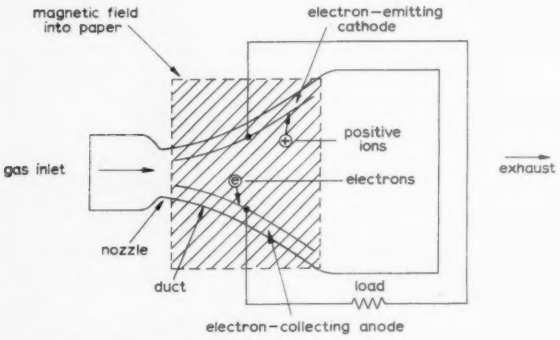
In the conventional turbogenerator, chemical energy, obtained from the fuel, is used to generate steam. The heat energy of the steam is converted into kinetic energy, which acts on the turbine blades and drives a metallic conductor through a magnetic field, thus producing electrical energy.

Such a process is inherently inefficient owing to the losses occurring at each energy conversion, the greatest loss occurring when the heat energy is converted to mechanical energy. The thermal efficiency has been improved by the production of the steam at higher temperatures and pressures, although

this in turn has led to more complex plant and higher capital costs. Even so, the over-all thermal efficiency of the most efficient power station is only about 40%, with a possibility that this will rise in some years' time to about 45%.

Basic principle of m.h.d. generation

It was suggested some years ago that an improvement in the efficiency of conversion of fuel energy to electrical energy could be brought about by using heated gas as the moving conductor. The basic principle of m.h.d. generation is that the gases are heated by fossil or nuclear fuels and charged particles are introduced by some means.



1 *Transverse-field generator*

The gases are passed through a nozzle, thus converting part of their heat energy to kinetic energy. Some of the kinetic energy is extracted and transferred to an electric circuit. Estimates have placed the possible efficiency of such a process as high as 56%. The gain in efficiency is due to the facts that the combustion gases would be at a higher initial temperature than the steam and that certain processes inherent in the steam cycle would be unnecessary.

Efficiency

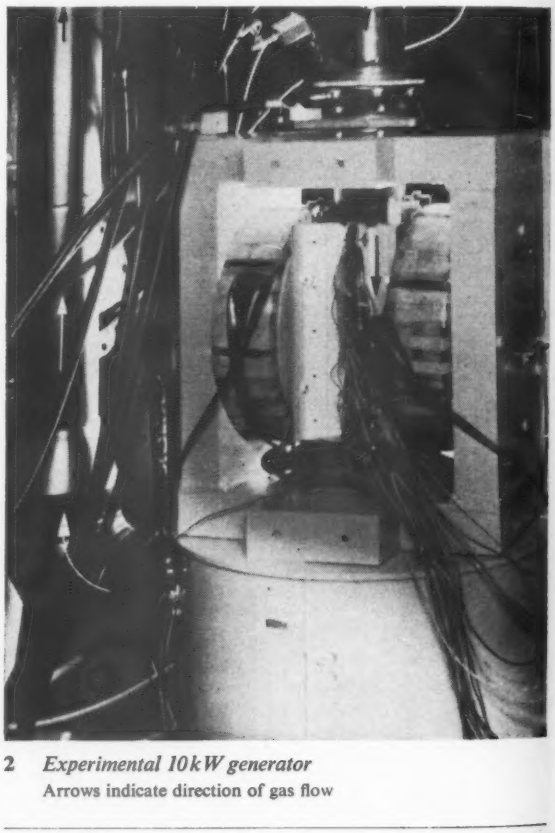
The basic thermodynamic cycle suggested for m.h.d. generators is similar to a gas-turbine cycle in which the turbine of the turbocompressor is replaced by a nozzle. The maximum possible efficiency η is the Carnot efficiency, which is given by $\eta = (T_1 - T_0)/T_1$.

Even with preheating, the highest-possible flame temperature T_1 of low-grade fossil fuels is about 3000°K, and if T_0, the temperature at which heat is rejected, is 300°K, Carnot efficiencies in the range 0·75–0·90 are possible, compared with 0·45–0·65 for present-day heat engines. The practical over-all thermal efficiency tends to be only a fraction of the Carnot efficiency, and hence the importance of raising as much as possible the initial temperature is easily seen.

Only recently has it become possible to base such ideas on actual experimental data. Various m.h.d. generators have been suggested and tentative studies on thermodynamic cycles carried out. Estimates show that, for the generation of large blocks of power, an m.h.d. generator would need to be backed by a steam cycle and a conventional turbogenerator in order to make full use of the heat energy of the combustion gases. Work connected with missile and space problems has developed the beginning of an understanding of the electrical conductivity of gases at high temperatures and enabled experimental generators to be built.

Transverse-field generator

The transverse-field generator, shown in Fig. 1, is the simplest type of generator. Here the hot gases are expanded adiabatically through a nozzle, which accelerates them to a high velocity. They then pass into a duct. In the duct, they pass through a region of transverse magnetic flux provided by an electromagnet, whose poles are thermally insulated from the hot gases. The charged particles travel in circular orbits, with a steady drift at right-angles to both the field and the flow. The electrons and positive ions become separated, and the electrons are collected by electrodes.



2 *Experimental 10 kW generator*
Arrows indicate direction of gas flow

The interaction of the magnetic field and the output current causes a braking effect on the electrons. If the gases are slowed down to one-half their original speed, about three-quarters of their energy would, theoretically, be converted to electrical energy. The required conductivity of the heated

gases would appear to be obtainable by the addition of small amounts of materials (such as potassium) having low ionization potentials. Such a process is known as 'seeding'.

One handicap of the transverse-field generator is that it generates direct current, and, for bulk power supplies, conversion to alternating current, by means of inverters, would be required. Further types of generator using radial magnetic fields, alternating magnetic fields or inductance variation have been suggested, and some of these could be arranged to produce a.c. power.

Experimental generators

An American experimental 10kW generator is shown in Fig. 2. It consists of an electrically heated plasma jet mounted above an electromagnet. The magnet, with the generator channel between its poles, is supported by a tank, which confines the exhaust and is vented to the roof.

Helium and argon have been used as working fluids, seeded in each case with 1% (atomic) of potassium in the form of powdered potassium carbonate. The generator consists of an insulated channel $1 \times 3 \times 20$in., electrodes and a magnetic field of $1{\cdot}4$Wb/m^2. Conductivities ranged from 80 to 150mho/m. With argon seeded with 1% potassium, a flow rate of $0{\cdot}3$kg/s and a temperature of 2800°K, the peak output was 430A at 27V. Owing to a lack of suitable cooling, the maximum length of a run was limited to about 10sec.

An experimental generator, operating on combustion products rather than on electrically heated gas, is also in operation in America. It uses the products of combustion of furnace oil and oxygen, which are seeded with potassium. It has developed 10kW of d.c. power and has been run on load for as long as 15min continuously.

Conclusions

M.H.D. power generation could well be a solution in the search for higher thermal efficiencies and so justifies the major commercial-research effort that it is now receiving. Research is required into the detailed behaviour of high-temperature gases in magnetic fields, collision cross-section of gases, effects of turbulence and discharge, seeding materials, and refractory materials for the containing walls. Compared with conventional turbogenerators, m.h.d. generators would be more efficient and have a higher reliability. They may also have a reduced weight : power ratio, which would be an advantage in applications to space vehicles. 621.313.1 : 621.387

THE JOURNAL DIGEST | PAPERS PUBLISHED

In this monthly section are summaries of papers published in the *Proceedings* of The Institution which have not been read at Institution meetings. They are included primarily for reference. Reprints, price 2s., become available about two months after publication

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Design of a noise generator

A summary of an Electronics and Communications Section paper (3714) 'The design of a noise generator for measurements in the frequency range 30–1250 Mc/s' by I. A. Harris, Associate Member. The paper is published this month in Part B of the Proceedings. The author is at the Laboratories of the Electrical Inspection Directorate, Ministry of Aviation.

DEPARTURE of the source impedance of a noise generator from the nominal value gives rise to an uncertainty in the measurement of noise factor. A critical examination of the problem shows that, to obtain an uncertainty on this account of less than 2%, a source v.s.w.r. of about $0{\cdot}98$ is required. Because existing noise generators seldom meet this requirement and because there is a need for more consistent measurements of noise than those obtained hitherto at frequencies up to about 1200Mc/s, a new noise generator has been developed.

A description of the design, construction, calibration and use of this noise generator is given. It employs a precision source resistor of 50Ω and a pair of specially developed thermionic diodes (E2790), using a form of diode mount designed to eliminate the effects of diode capacitance so that a v.s.w.r. better than $0{\cdot}98$ is obtained at all frequencies in the range. It is an absolute noise generator, with an accuracy in noise level within ±2% at frequencies up to about 300Mc/s, but requires calibration at a single level for frequencies up to 1250Mc/s. At present, this has been achieved with an estimated uncertainty of about ±5% in noise level. 621.373 : 621.317.34

Crystal detectors to cover the frequency band 26-40 Gc/s

A summary of an Electronics and Communications Section paper (3699) with the above title by H. V. Shurmer, M.Sc., Ph.D., Associate Member. The paper is published this month in Part B of the Proceedings. The author is with Associated Electrical Industries (Rugby) Ltd.

AFTER referring to unsuccessful attempts based on a wafer-type mount, the author describes a coaxial unit that operates over the frequency band 26–40Gc/s and is mechanically interchangeable with the American crystal 1N 53. The

Papers published (continued)

new crystal employs a silicon point contact of high sensitivity, and the mount was designed to give the best v.s.w.r. over the entire bandwidth.

The design technique is described in detail, and experimental data are summarized. Notwithstanding some difficulty in manufacturing to the required sensitivity, a broad-band design has been achieved, and the capabilities of Q-band detector crystals have been gauged. 621.376.3.029.64: 621.372.825

Accurate simulator for sampled-data systems

A summary of a Measurement and Control Section paper (3730) 'Design of an accurate simulator for sampled-data systems' by M. J. Somerville, Ph.D., Associate Member, and G. F. Turnbull, M.Sc., Graduate. The paper will be published in Part B of the Proceedings. The authors are at the Electrical Engineering Laboratories, University of Manchester.

A DETAILED consideration is given of certain specialized units by means of which an analogue machine, normally used for simulation of continuous systems, may be adapted to allow also simulation of sampled-data systems. Emphasis is mainly on those circuits and methods that achieve best accuracy, the order of within 0·1% being possible when valve circuits are employed. 621–52: 681.142

Current-steering commutators and ring counters

A summary of a Measurement and Control Section paper (3713) 'Ferrite-core current-steering commutators and ring counters' by H. J. Andrews, Graduate. The paper will be published in Part B of the Proceedings. The author, formerly with International Computers and Tabulators (Engineering) Ltd., is now with Redifon Ltd.

MAGNETIC cores having approximately rectangular hysteresis loops and bistable properties have been used as logic and switching elements for several years. They offer exceptional reliability, flexibility and cheapness for systems not required to operate at extremely high speeds.

The principle of current-steering circuits based on ferrite-core and semiconductor-diode combinations has been discussed by previous authors. The present author describes current-steering commutators that steer well-defined current pulses sequentially along a number of paths. Expressions are included that, although simplified, are sufficient to allow reliable systems to be designed, and a practical example is included in the appendix.

There is no general rule to be followed when designing a core device: the choice of core material and size should be decided individually for a particular application. It is always advisable to study manufacturers' published data and to design adequate circuits in view of the inexactness of the assumption that the spread of switching characteristics from core to core is negligible. 621.374.32: 621.318.1

Microwave magnetic-field measurements

A summary of an Electronics and Communications Section paper (3709) 'Microwave magnetic-field measurements by a modulated scattering technique' by Bradley J. Strait, M.S.E.E., and David K. Cheng, Sc.D. The paper will be published in Part B of the Proceedings. The authors are in the Electrical Engineering Department, Syracuse University, Syracuse, N.Y., U.S.A.

THE authors describe an experimental technique for measuring microwave magnetic diffraction fields. They establish the capabilities of the modulated scattering method when a small loop containing two subminiature diodes in parallel is used as the scatterer. Extensive data for amplitude and phase distributions of both the electric and the magnetic fields over the entire region of a circular aperture irradiated by a plane wave have been obtained. Distributions of diffraction fields both in front of and behind the aperture are presented. Discussions on cross-polarization components and the effect of screen thickness are included. 621.317.42.029.65

THE JOURNAL DIGEST | IN THE PROCEEDINGS

The date in italics is that of the Journal review, special article or synopsis. Where given, the date in capitals is the month in which a paper or monograph was published individually

PART A. POWER ENGINEERING (OCTOBER 1961)

See the Journal for October 1961, p. 618

PART B. ELECTRONIC AND COMMUNICATION ENGINEERING (NOVEMBER 1961)

P. SCHAGEN, PH.D. PAPER 3564E, MAY 1961 **The banana-tube display system** *October 1961*

B. A. EASTWELL, B.SC., *and* P. SCHAGEN, PH.D. PAPER 3566E, MAY 1961 **Development of the banana tube** *October 1961*

H. HOWDEN. PAPER 3562E, MAY 1961 **Mechanical and manufacturing aspects of the banana-tube colour-television display system** *October 1961*

K. G. FREEMAN, B.SC. PAPER 3561E, MAY 1961 **Circuits for the banana-tube colour-television display system** *October 1961*

R. N. JACKSON. PAPER 3565E, MAY 1961 **Colorimetry of the banana-tube colour-television display system** *October 1961*

K. G. FREEMAN, B.SC., *and* B. R. OVERTON, B.SC. PAPER 3563E, MAY 1961 **Appraisal of the banana-tube colour-television display system** *October 1961*

Communicated discussion on **Television band compression by contour interpolation**

JOHN BROWN, D.SC.(ENG.), *and* E. V. JULL, B.SC., PH.D. PAPER 3649E **The prediction of aerial radiation patterns from near-field measurements** *October 1961*

D. MIDGLEY, B.SC.(ENG.), PH.D. PAPER 3718E **A theory of receiving aerials applied to the reradiation of an electromagnetic horn** *October 1961*

I. A. HARRIS. PAPER 3714E **The design of a noise generator for measurements in the frequency range 30–1250 Mc/s** *November 1961*

H. V. SHURMER, M.SC., PH.D. PAPER 3699E **Crystal detectors to cover the frequency band 26–40 Gc/s** *November 1961*

A. F. NAGY, M.E., M.SC., *and* H. B. NIEMANN, B.E. **Switching on–off type filament emission regulator** (communication)

J. MILLS, M.ENG.SC. PAPER 3727M **An output prediction system to improve the performance of on–off and saturating control systems** *October 1961*

PART C. MONOGRAPHS (SEPTEMBER 1961)

See the Journal for September 1961, p. 567

THE JOURNAL DIGEST | MONOGRAPHS

Monographs are first published individually, price 2s., and are republished later in Part C of the Proceedings of The Institution. As soon as the separate monographs are available, summaries are given in this feature.

Applications quoting the serial number of the monographs as well as the author's name, and accompanied by a remittance, should be addressed to the Secretary of The Institution.

For convenience, books of five vouchers for this purpose can be obtained in advance, price 10s.

The analysis of thick-cylinder induction machines

Monograph 477U

J. C. WEST, PH.D., D.SC., *and* D. E. HESMONDHALGH, M.SC.

AN analysis is given from fundamental principles of the performance of induction machines having smooth thick-cylinder rotors, both for polyphase and single-phase conditions. Flux and current distributions are obtained, together with torque/speed characteristics and numerical values computed from the derived formulas. Experimental results obtained from a specially constructed thick-walled rotor machine and from a single-sided linear machine are given for comparison.

Construction and characteristics of a 340 MeV electron synchrotron magnet

Monograph 478M

C. AMBASANKARAN, M.A., S. E. BARDEN, E. A. FINLAY, B.SC., B.E., PH.D., J. B. HANSELL, B.SC., *and* J. R. PERRY, M.SC.(TECH.)

FOLLOWING an outline of the original specification of the magnet, its construction is described in detail. An abridged description of the magnet power supply is given. The characteristics of the magnet as revealed by comprehensive magnetic measurements are recorded, with a brief outline of the measuring techniques used.

The quantities measured include the betatron orbit radius, the azimuthal variations of the guiding field at injection and as acceleration proceeds, and the field exponent n and its variation with azimuth. Measurements of many of these quantities were taken over a wide range of magnet excitation, and they led to a choice of the quarter-cycle of the magnet waveform to be used for acceleration, and of the value to which the magnet excitation should be reduced for the initial attempt to produce a beam.

An attempt is made to explain qualitatively some rather obscure aspects of the magnet's behaviour at the start of its operating cycle.

Space–frequency equivalence in directional arrays

Monograph 479

PROF. D. G. TUCKER, D.SC.

PREVIOUS proposals that a directional receiving array of given directional response can be made either from a number of receiving elements with a single narrow-band signal, or from two receiving elements with a signal comprising a number of separate narrow frequency bands, are examined from the points of view of the exactness of the equivalence and of the application of super-directivity.

It is concluded that no exact equivalence exists in practical terms but that superdirectivity can certainly be obtained by the second method, as well as by the first. The application of the second method to a transmitting array is shown to be possible, and the law of reciprocity may be made to hold to a limited extent; but multi-frequency two-element transmitters and receivers cannot work together in the way in which multi-element single-frequency transmitters and receivers can.

Theory of variable-capacitance parametric amplifiers

Monograph 480E

B. J. ROBINSON, M.SC., PH.D.

AN analysis is presented of variable-capacitance parametric amplifiers for the case where there is a loss resistance in series with the capacitance. Such a resistance provides the major form of loss in a reverse-biased semiconductor diode.

It is shown that the coupling of two circuits by a pumped variable capacitance can be described by a simple equivalent circuit that has a direct physical interpretation. The characteristics of regenerative amplifiers and convertors, and of non-inverting convertors, are deduced from the equivalent circuits. The gain, bandwidth and noise properties of these amplifiers or convertors are shown to depend on two parameters of the pumped variable capacitance C, the mean Q at the signal frequency and the normalized amplitude of the variation of $1/C$ at the pump frequency. The noise temperature in each case is a function only of the product of these two parameters and the ratio of signal to idler (or output) frequencies.

Particular attention is paid to finding the optimum operating conditions, and a brief discussion is given of the effects of variations of the capacitance at harmonics of the pump frequency, and of higher sidebands.

Monographs (continued)

Semiconductor circuits for ternary logic

Monograph 482E

R. P. HALLWORTH, DIP.TECH.(ENG.), M.SC.TECH., *and* F. G. HEATH, B.SC.

THE advantages that can be obtained from using a ternary or higher-order system are enumerated. The various techniques using semiconductor devices are described with particular reference to the ternary system, and the circuits that have been developed from these techniques are reviewed. The prototype circuits described have been developed primarily to show the feasibility of a ternary computer or data-processing equipment, and it is expected that further engineering design will be needed to construct a large higher-speed machine. The main types of logic are surveyed, and the principal operators required to mechanize a system are discussed.

A general theory of amplitude quantization with application to correlation determination

Monograph 481M

D. G. WATTS, B.A.SC., M.A.SC.

A GENERAL theory of amplitude quantization is presented and is used to investigate the effects of signal quantization on the determination of correlation functions. Theoretical expressions are obtained for the cross-correlation between signals and quantization noises and for the cross-correlation between quantization noises.

From considerations of the theory of amplitude quantization, a general form for multiplier correlators is determined. The perfect analogue correlator, the digital computer applied to correlation determination, the relay correlator and the polarity-coincidence correlator are all shown to be special cases of this general form. In addition, a new correlation method, termed Stieltjes correlation, is deduced. This method, in which one of the inputs is coarsely quantized and the other is not, is described in detail and is shown to possess many advantages over the correlators mentioned above.

An alternative derivation of Orlov's synthesis formula for non-uniform lines

Monograph 483E

C. B. SHARPE

ORLOV's synthesis formula is a Fourier-type relation between the distribution function of a non-uniform line and the input and output reflection coefficients. It is shown that Orlov's result can be derived by treating the analysis of a non-uniform line as a one-dimensional scattering problem. The transmission-line equations are first transformed into an integral equation by employing the appropriate Green's function. The approximate solution of this equation obtained by truncating the Fredholm series leads to Orlov's formula.

THE JOURNAL DIGEST | PAPERS TO BE READ

Papers accepted for reading at meetings and eventual publication in the Proceedings of The Institution are first published individually. The separate papers are supplied free of charge, and as soon as they become available they are summarized in this feature.

Those who obtain a copy of a paper published individually are urged—if they do not take the Part of the Proceedings in which it will be republished—to apply in due course for a reprint, as this is the final and correct version and includes the discussion. Reprints become available, price 2s., about two months after the appearance of the paper in the Proceedings.

Applications quoting the serial number of the paper or reprint as well as the author's name, and accompanied by a remittance where appropriate, should be addressed to the Secretary of The Institution. For convenience, books of five vouchers for this purpose can be obtained in advance, price 10s.

The B.B.C. Television Centre and its technical facilities

Paper 3786E, *Part B*

F. C. McLEAN, C.B.E., B.SC., H. W. BAKER, O.B.E., *and* C. H. COLBORN, B.SC.

THE British Broadcasting Corporation Television Centre is the first television headquarters and programme-production centre built by the Corporation and one of the few buildings in the world constructed expressly for television-programme origination. The Centre is at present equipped for producing about 20 hours of programme per week from four production studios and their ancillary areas and for maintaining continuity of the network programme as a whole. The Centre is principally intended for the production of live programmes but has many facilities for the production and reproduction of programmes in recorded form. When completed, the Centre will have some ten or 11 studios and will be capable of originating and handling programmes for two programme chains.

The Centre includes facilities for all phases of work concerned with programme origination, including recording and standards conversion. It is initially equipped for black-and-white operation on 405 line standards but has been designed so as to be ready for conversion to the requirements of other television standards and for colour.

To meet the large power need of television production, the Centre contains a large amount of heavy power equipment.

To be read on the 23rd November 1961

Electrical aspects of Hunterston nuclear generating station

Paper 3770S, *Part A*

J. HENDERSON, C.B.E., M.C., B.SC., G. F. KENNEDY, M.A., *and* K. J. WOOTTON, B.SC., PH.D.

THE authors survey the electrical-engineering aspects of the design of Hunterston nuclear generating station that are considered to be of general interest but exclude reactor instrumentation and control equipment.

The location of Hunterston and its relation and connections to the supply system of the South of Scotland Electricity Board are first described. The authors then consider the special operational features of a nuclear station and discuss the over-all station-control system.

The auxiliary supply system is dealt with, and the differences between nuclear and conventional station practice are indicated, with particular reference to the extensive 'essential-supplies' system. The largest electrical auxiliaries are the gas-circulator drives, and, since their design is unusual, these drives are studied in some detail. The authors conclude with a description of the starting-up and operation of the station.

To be read on the 13th December 1961

SOME RECENT BOOKS

SEMICONDUCTOR DEVICES AND APPLICATIONS

R. A. GREINER

McGRAW-HILL. 1961. 493 PP. £4 17S.

TRANSISTORS AND ACTIVE CIRCUITS

J. G. LINVILL and J. F. GIBBONS

McGRAW-HILL. 1961. 515 PP. £5 12S. 6D.

BECAUSE the number of readers for texts on transistors must now be as large as any that has existed for one branch of electronic engineering, the frequent appearance of new works on the subject—even two from the same publisher in one year—must come as no surprise. The readers can be divided into groups, perhaps a little arbitrarily, and most authors are content to write for one group only in one book. These two new volumes in the McGraw-Hill Electrical and Electronic Engineering Series will certainly not have much overlap in readership.

Dr. Greiner, trained in both physics and electrical engineering, has attempted an introductory textbook that first seeks to explain sufficient solid-state physics to make broadly comprehensible the basic physical mechanisms of transistors and to deduce the key electrical properties, but a more compact statement could have been as effectively made of the early sections. He converts these electrical properties into forms most suited to engineers and concludes by describing, sometimes with analytical backing, the use of transistors in amplifiers (small-signal, power and d.c.), oscillators and switching circuits.

By and large, a uniform level of writing is maintained and little is unorthodox; the chapters on biasing and stabilization and on power supplies are better than in most books. The last 80 pp., made up of references, several short appendixes, lists of device characteristics, and problems, are of mixed value.

Prof. Linvill and Dr. Gibbons offer much stronger meat: with their authority in the field they are able to break with convention and introduce new concepts and analytical methods. Their work is in three parts. The first describes the physical processes in semiconductors that affect transistor behaviour and proposes new elements, based on diffusance, combinance and storance, for insertion in the equivalent circuits of transistors. The second presents two-port network theory, concentrating on such subjects as the determination of the generator and load impedances for optimizing power gain and the stability and sensitivity to component changes of linear systems. All this will be of much value to experienced workers wishing to obtain a many-sided view of the transistor as a circuit-element.

The third part surveys transistor circuits in the light of the first two parts, again frequently disdaining convention. Thus a common approach is made to all contaminating signals in amplifiers (noise, drift and distortions) and another to the defects of i.f. amplifiers; chapters on feedback and on non-regenerative and regenerative switching are perhaps unduly condensed. The volume is important, even if its proposals do not all take root; it must be read slowly, but the effort will be well rewarded.

J. R. TILLMAN

HIGH VOLTAGE DISTRIBUTION PRACTICE

J. H. GRIDLEY (*Editor*)

ERNEST BENN. 1961. 240 PP. £2 5S.

THIS volume makes available to a wider circle the material of a series of lectures given by practising engineers at the Regent Street Polytechnic, London. Although the title refers to high-voltage distrbution iin general, the text is concerned almost exclusively with British practice on rural h.v. networks. The contributions cover all aspects of this subject, from planning and design, through construction, to operation and maintenance, with chapters on protection and lightning. Extracts are given from the relevant regulations. Many useful tables and curves are included, dealing with fault levels, voltage drop, cost comparisons, etc.

Covering such a wide field, it is a useful desk-book for the engineer concerned with distribution, as it gives practical guidance to current practice in various parts of Britain. For the student it furnishes a helpful introduction to the whole topic.

The question of earthing is referred to in several places, but its importance would have justified a separate chapter, bringing together the several aspects of the matter.

The recommended levels for security of supply are given undue authority in the book: they are intended for guidance only, and in practice they are generally exceeded.

H. G. BELL

AN INTRODUCTION TO THE PRINCIPLES OF COMMUNICATION THEORY

J. C. HANCOCK

McGRAW-HILL. 1961. 253 PP. £3 14S.

COMMUNICATION theory may be said to have reached maturity as a science in its own right in the late 1940s. The following decade has seen on the one hand a consolidation of early work through the presentation of unified treatments, and on the other an extension of the theory through application to certain specific problems. It is fair to say that much of this latter work has been highly academic in character, and the practical results have seemed somewhat meagre in relation to the intensive mathematical effort deployed.

That progress in any given scientific field should be subject to the law of diminishing returns is quite normal, however. Furthermore, the imagination of the founders of a theory usually merits greater respect than the diligence of the

'scientific hodsmen' (to quote A. W. Montgomery) who later elaborate the superstructure.

It is not surprising, therefore, that Dr. Hancock's book contains little that was not understood by 1950. (The references may suggest the contrary, but this is because the author prefers in general to quote textbooks rather than original papers.) Since the work is intended to provide a general background to the subject for engineering students, this concentration on 'classical' essentials is to be commended rather than criticized.

Indeed it is difficult to fault the volume. A wide variety of useful topics is covered, the level of treatment is reasonably uniform, and the engineering significance of each theorem is consistently demonstrated. The text is well illustrated and liberally endowed with both worked examples and problems for the reader to solve for himself.

The topics covered include a summary of Fourier-transform theory, a fairly detailed comparison of modulation systems, elementary probability theory, the response of networks to random inputs, non-linear systems, optimum filtering, entropy as a measure of information capacity, the properties of noise, and the comparative performance of several practical communication and radar systems. In any future edition, however, the author might usefully consider expanding the sections on pulse transmission (particularly p.c.m.), which are thin, and the inclusion of a section concerning the effects of dispersive media on the information capacity of a channel for different methods of modulation and multiplexing.

One would like to feel that the contents of the book were familiar to all telecommunication engineers of graduate standing. While the average engineer will have little opportunity to apply the mathematical techniques, a clear understanding of communication principles is essential to systematic thinking and the avoidance of wasted effort on unsound propositions.

J. M. C. DUKES

SEMICONDUCTING III–V COMPOUNDS

C. HILSUM and A. C. ROSE-INNES

PERGAMON PRESS. 1961. 239 PP. £3

DURING the past decade, intensive research work has been carried out in a number of laboratories on the properties of semiconductors formed by the combination of elements of Group IIIb of the Periodic Table with those of Group Vb. An excellent account of the results so far achieved is provided in this book, by authors who have themselves made notable contributions to the subject.

The reader is assumed to be familiar with the general theory of semiconductors and with the more important properties of silicon and germanium. He will then find in the text a systematic account of the corresponding properties of the III–V compounds, and the authors have been at some pains to call attention to the way in which these compounds differ from semiconductors that, apart from impurities, contain only one element.

Chapters are devoted to crystal structure, band structure, impurities and defects, electrical properties and optical properties, and in each case the same plan is followed. The chapter opens with a review of the relevant general theory, and this is followed by a detailed discussion of each compound for which experimental results are available. These sections should prove of great value to physicists specializing in this field.

The electrical engineer is likely to be more interested in two chapters devoted respectively to the preparation of the compounds and to a review of the practical uses to which they have been put. The first gives a clear account of the present state of the art and of the difficulties still to be overcome, while the second goes into sufficient detail to show what properties determine the choice of compound in certain typical applications.

From every point of view, the book deserves a warm welcome.

C. W. OATLEY

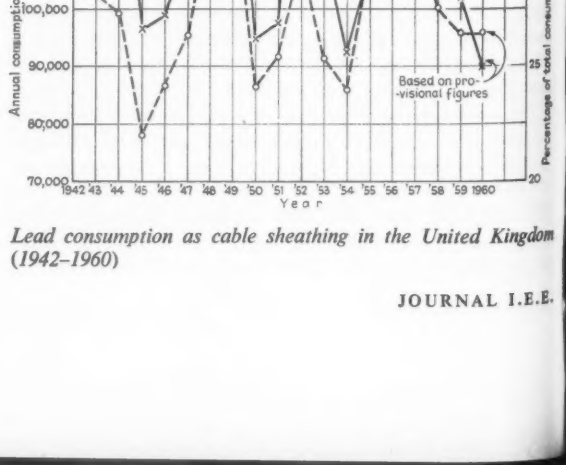
LEAD AND LEAD ALLOYS FOR CABLE SHEATHING

S. A. HISCOCK

ERNEST BENN. 1961. 361 PP. £3 10S.

THE appearance of a book on electric cables is a rare event, and a work of this magnitude dealing solely with one component, the lead sheath, must be unique.

It contains a wealth of information on the physical, metallurgical and technical properties and the behaviour of lead used as a protective sheath for electric cables. 260 references are reviewed, from the time lead was first introduced for this purpose until today. The text is supported by many diagrams and excellent photographs, together with the author's views on the more important aspects of the subject, which should stimulate serious discussion and thought.



Lead consumption as cable sheathing in the United Kingdom (1942–1960)

The contents can be divided roughly into four parts: a brief historical review, with accounts of contemporary extrusion presses and machines; metallurgical considerations relative to the requirements in a cable sheath and the influence of alloys; examination of the limitations of extrusion machines and operations; and, finally, a study of the interrelation of extrusion variables, followed by a critical examination of continuous extrusion.

Researchers in universities, appropriate laboratories and manufacturing organizations investigating these problems should find the book extremely valuable. At the same time, the practical approach is somewhat limited in relation to the techniques of lead sheathing, now well established. There are, however, sections that should prove useful to all those associated with the manufacture and application of lead-sheathed electric cables: e.g. the descriptions of the Hansson–Robertson continuous-extrusion machine, properties of alloys, defects in lead sheaths, etc.

C. T. W. SUTTON

TELEGRAPHEN-LAND-UND-SEEKABEL FERNSPRECH-SEEKABEL

K. KNEBEL

GOSLAR: VERLAG ERICH HERZOG. 1960. 254PP. £3 16S.

THE author states that this book was prepared in order to fill a need for a comprehensive survey of submarine-cable techniques. Thus, although land telegraph cables are mentioned in the title, only a brief historical reference is made to this subject.

The rest of the text is concerned with a detailed description of types of submarine-cable link, nearly half of it being devoted to transoceanic telephone systems. The construction of various kinds of cable is illustrated by numerous dimensioned cross-sectional drawings, and details of their electrical specifications are given. Methods of lifting and repairing submarine cables are described, and some reference is made to the problems of handling submerged telephone repeaters and equalizers.

Although much of the information contained is already available elsewhere in the English language, it is presented here in a concise and convenient form, and the book should form a useful reference work for cable engineers.

V. G. WELSBY

ELECTRONIC SURVEYING AND MAPPING

S. LAURILA

OHIO STATE UNIVERSITY PRESS. 1960. 294 PP. $6

THIS book is intended to serve as a university textbook for courses in electronic surveying, but it may also be regarded as an introductory guide for geodesists unfamiliar with electronics and for electronics engineers who are interested in the application of radar and navigational systems to surveying.

For this reason the text is divided into three parts, the first of which gives a simplified and rather superficial description of pulse transmitters, receivers, cathode-ray tubes and aerials used in surveying systems. A short history, a general introduction and some fundamentals of electronics are also included.

More-interesting material is included in the second part, comprising about two-thirds of the volume. This describes in detail such systems as Shoran, Decca, Gee and radar distance measuring. Loran-C might well be added in any future edition.

The third part deals with a number of special problems, important both to navigation and survey. These include the accuracy of computation of propagation velocity, the curvature of ray paths, and the effect of soil conductivity. There are also a few sections on certain geometrical aspects of surveying, and these could well be expanded to give more information on mapping principles.

The book is well printed and illustrated but contains a number of typographical errors and at least one incorrectly titled diagram. A glossary and bibliography are appended.

J. C. FARMER

COMPUTER PROGRAMMING FUNDAMENTALS

H. D. LEEDS and G. M. WEINBERG

McGRAW-HILL. 1961. 368PP. £2 6S. 6D.

IN their preface, the authors state that this book is intended to be an introductory text on digital computing. They have produced a well written and very readable work, with carefully thought-out examples requiring no mathematics beyond school algebra, and drawn from relatively common experiences. The treatment is thorough, apart from the surprising omission of any but the briefest reference to Autocoding techniques, which are now becoming increasingly important.

Although the authors have referred extensively to the IBM 7090 where concrete examples are required, this is no 7090 programming manual but contains a full discussion of principles applicable to all machines. This is particularly true of the chapters on flow diagrams, programme testing and the organization of production runs, which emphasize the extreme importance of these aspects and the great benefits to be gained from the formation of good programming habits. For the engineer hoping to make use of a computer, these parts of the book would certainly be useful. As, however, he would probably be using an automatic coding system, much of the detail in the chapters on coding would be somewhat irrelevant.

C. M. POPPLEWELL

ADVANCES IN ELECTRONICS AND ELECTRON PHYSICS—Vol. 14

L. MARTON (*Editor*)

NEW YORK: ACADEMIC PRESS. 1961. 341PP. $11

AS the material was available, this volume has been published unusually soon after its predecessor. The first two chapters, having a physicochemical flavour, are unlikely to interest electrical engineers. They are 'The electron as a chemical entity' by C. G. B. Garrett, which deals with equilibrium states of assemblies in which at least one of the phases is

a semiconductor; and 'Problems of photoconductivity' by P. Görlich, where several topics of current interest in this field are studied.

The remaining four chapters will be more to the electronics engineer's taste. 'Strong-focusing lenses' by Albert Septier (translated from the French by H. A. Fowler) occupies over a third of the whole book and comprehensively covers the theory and practice of quadrupole electric and magnetic lenses. 'Hydrogen thyratrons' by S. Goldberg and J. Rothstein reviews progress in the understanding and engineering of these tubes, and pinpoints their status in relation to that of other electronic switching devices. In 'Cerenkov radiation at microwave frequencies', H. Lashinsky discusses the problem of generating microwaves by the Cerenkov effect. Finally, 'High-power axial-beam tubes' by T. Moreno examines problems involved in high-power klystron and travelling-wave-tube design. Recent advances, and the future role of these tubes, are discussed.

This series has set a high standard that this volume adequately maintains. V. ROBERTS

INTRODUCTION TO TRANSIENTS

D. K. McCLEERY

CHAPMAN AND HALL. 1961. 232 PP. £2 2S.

THIS text presents a study of transient phenomena using Heaviside's operational method. The late author (who died while the book was in press) suggests that this method will be preferable as an introduction for less-mathematically-minded students, including those who will eventually study the Laplace transform. However, weaker students even of A.2 level usually find little difficulty in applying differential equations or the Laplace transform to circuit problems, so that it is doubtful whether there is any need to avoid these techniques for students preparing for more advanced examinations, and to use Heaviside's operational method if regarded as an easier introduction.

The book opens with some elementary considerations in which the Fourier series of a number of waveforms are given and the unit step function is defined. Heaviside's operational method is introduced and a number of transforms are derived, followed by a note on the impulse function. A chapter on oscillatory conditions deals mainly with two-element circuits, although the application of a step voltage and also of an impulsive voltage to a circuit containing resistance, capacitance and inductance is considered. The work in later chapters is concerned with transients in thermionic-valve circuits; with Heaviside's expansion theorem and its application to transmission lines and cables; with surges in transmission lines, which requires the derivation of the transforms of a number of waveforms; and finally with the response of circuits to alternating stimuli.

Suitable examples for practice are provided throughout the text, which may prove useful to engineers as an introduction to transients in which little detailed knowledge of differential equations is needed. F. H. JACKSON

METEOR SCIENCE AND ENGINEERING

D. W. R. McKINLEY

McGRAW-HILL. 1961. 309 PP. £4 17S.

THIS is a book that the author is very well qualified to write, for Dr. McKinley has been interested in, and has personally contributed greatly to, research on meteors for nearly 15 years. He has summarized the major observational and theoretical developments in meteor science, which he defines as the spatial history of the particles and the effects they create in the upper atmosphere; and he indicates many of the problems in this field still requiring elucidation.

After a historical survey, he goes on to describe some elements of astronomy and radio essential to the main thesis; there then follow chapters on visual and photographic and on radio observing techniques. Chapters 5–8 contain an account of the observational data on meteors obtained by the various methods and a discussion of the data in relation to astronomy, the physical theory of meteors and radio-echo theory. Chapter 9 is concerned with the forward-scatter from meteor trails, of importance in radiocommunication, particularly at very high frequencies; and the final chapter describes several miscellaneous phenomena associated with meteors, including radio-noise emission from them, their geomagnetic effects, their contribution to the ionization of the E-region of the ionosphere, and their relation to rainfall.

Dr. McKinley is to be congratulated on having competently written a most interesting book. It is very well illustrated by a large number of clear line diagrams and excellent photographs, and a comprehensive bibliography is a useful feature. The volume should appeal to a wide cross-section of scientists and engineers; and the radio engineer will find the concise and up-to-date account of the practical application of the forward-scattering properties of meteor trails to communication systems particularly valuable.

J. A. SAXTON

DIGITAL APPLICATIONS OF MAGNETIC DEVICES

A. J. MEYERHOFF (*Editor*)

JOHN WILEY. 1960. 604 PP. £5 12S.

THIS volume was written by a team of 25 authors, mostly from the Burroughs Corporation Research Center at the request of the U.S. Office of Naval Research, to serve as a reference textbook on digital magnetic circuits. It is divided into six parts: fundamentals, parallel magnetic amplifiers, pulse amplifiers, memories, transistor–magnetic pulse amplifiers, and other techniques.

The bulk of the text is devoted to various aspects of core-diode circuits and includes a full treatment of the individual circuit performance and a discussion of the logical design of core-diode systems. The delay parallel magnetic pulse amplifier (commonly known as the one-core-per-bit circuit) is the basic core-diode circuit, with a delay network in the transfer loop between cores. The series magnetic pulse amplifier is known also as the half-cycle or Ramey amplifier.

There is a useful account of magnetic-core memories,

including two-core-per-bit techniques, and a description of such recent developments as the twistor, the magnetic film and superconductive devices.

The book contains a wealth of theoretical and design information and will not only serve as a useful work of reference for the practising engineer but can be profitably read by advanced students. R. L. GRIMSDALE

AUTOMATIC LANGUAGE TRANSLATION

A. G. OETTINGER

CAMBRIDGE, MASS.: HARVARD UNIVERSITY PRESS. LONDON: OXFORD UNIVERSITY PRESS. 1960. 380 PP. £4

ANTHONY OETTINGER was one of the early workers in the field of machine translation in the United States. His group at the Harvard Computational Laboratory have been responsible for constructing the first large-scale Russian–English dictionary to be tried on a computer. The present book describes much of the thinking of the Harvard group and gives numerous examples of technical minutiae drawn from their experience.

It is perhaps unfortunate that the author starts with a chapter on information-processing machines and selects as his device the UNIVAC, which is unfamiliar to many computer programmers and is hardly typical of modern practice. However, the text continues with discussions of coding and of general aspects of translation, which are quite good, and then turns to an excellent and comprehensive account of the Harvard techniques and results.

The first two chapters apart, the writing is lucid and the material important. The book is probably too advanced to form an introduction for the layman, but it will be a standard reference for all research workers in the subject. A. D. BOOTH

CROSSED-FIELD MICROWAVE DEVICES—Vols. 1 and 2

E. OKRESS (*Editor*)

NEW YORK: ACADEMIC PRESS. 1961. VOL. 1: 648 PP., £7 17S. 6D. VOL. 2: 520 PP., £6 8S. 6D.

THE book presents a progress review of recent work on crossed-field microwave devices by more than 50 contributors from the United States, France, Japan and Britain. About two-thirds of the first volume is occupied by the problems of the dynamic behaviour of electron beams in crossed fields and gives an excellent comparative assessment of modern theoretical approaches. Pre-oscillation phenomena and noise in magnetrons, the spontaneous growth of oscillations in beams running under smooth anodes, and beam interaction with slow-wave structures are extensively analysed. In view of the need for improved cathode-gun design, a useful chapter on new types of electron gun has been included.

The second volume really does study specific types of crossed-field device; and, indeed, voltage-tuned oscillators of the carcinotron and magnetron types and wide-band amplifiers of the non-reentrant magnetron family are discussed fairly fully, even though the fixed-frequency magnetron oscillator steals the limelight to a degree that the title of the book fails to indicate.

Readers who can patiently plod through the text will be rewarded by a thorough appreciation of the appalling difficulties facing the designers of microwave devices when even small-signal theories are suspect, owing to the lack of understanding of the initial steady-state conditions of crossed-field beams. Some useful, if empirical, design information is included here and there, and there is quite an amount of practical information on the constructional details and experimental behaviour of many devices.

Fifty eminent authors cannot be expected to display overmuch uniformity of style or technical agreement on such a controversial topic; but in spite of this the editorial team have succeeded in producing a textbook that will be of considerable value to those interested in modern microwave devices. There is a wealth of theoretical and practical information, and clear indications are given of those phenomena that are not yet understood. R. G. HULSE

FREQUENCY–POWER FORMULAS

P. PENFIELD, Jun.

JOHN WILEY. 1961. 168 PP. 32S.

THIS monograph seeks to answer the question: What systems obey the Manley–Rowe formulas? These formulas relate to power flow at various frequencies in a non-linear capacitor.

A property of linear, time-invariant elements is that no frequency conversion of energy takes place. Non-linear and time-varying elements, however, do show such conversion. For example, the active power into a non-linear loss-free capacitor is not necessarily zero, because a power input at one frequency may appear as a power output at another. The Manley–Rowe formulas (*Proceedings of The Institute of Radio Engineers*, 1956, **44**, (7), pp. 904–913) provide the energy-conservation theorems for such cases.

The theme of the book, which is substantially a doctorate thesis, is a discussion of a variety of systems that conform to the Manley–Rowe equations, making the point that they hold for any physical system having an energy-state function. The systems discussed include parametric generators, electron beams, induction motors, gyromagnetic media, and magneto-hydrodynamic fluids.

The text is clear and well composed. It will be of interest to mathematical-physicists working in the field of non-linear conversion devices. M. G. SAY

AN INTRODUCTION TO COMPUTATIONAL METHODS

K. A. REDISH

ENGLISH UNIVERSITIES PRESS. 1961. 211 PP. 30S.

THE author attempts to guide readers through a selection of elementary numerical methods. At almost every stage there are references to one of several well known works on the

subject, but the author makes little attempt to indicate the existence of more advanced methods than those that he describes. It is difficult to understand how the writer of a new book can justify omissions by the statement (p. 202) 'new methods are being developed and have not yet reached textbook level'.

There are chapters on simultaneous linear equations, non-linear equations, finite differences, interpolation, differentiation and integration, ordinary differential equations, and functions of two variables (including partial differential equations), and a miscellany on approximating functions, difference equations, latent roots and vectors, etc.

It is doubtful if the text has any advantages over many similar ones already available, and one would be better advised to try 'Modern computing methods' (H.M.S.O., 1959).

A. D. BOOTH

AN INTRODUCTION TO INFORMATION THEORY

F. M. REZA

McGRAW-HILL. 1961. 496 pp. £5 4s. 6d.

THE first point to note is that this book is concerned with theory, not with engineering; its least successful part is chapter 1, where there is a dubious analogy with a power-transmission system. Chapter 2 deals with the elements of probability theory for discrete systems, mentioning the binomial and Poisson distributions and those aspects of set theory that can be illustrated by Venn diagrams. There is not, however, a discussion of the physical circumstances that give rise to a Poisson distribution, and the Gaussian or normal distribution is not introduced until chapter 5 on continuous distributions.

Chapters 3 and 4 cover the entropy measure in communication and systems of binary coding, but chapters 5, 6 and 7 revert to elementary statistics. Chapter 9 on the transmission of band-limited signals is valuable, but then chapter 10 switches back to a discussion of stochastic processes as a prelude to the theory of channel capacity. The section on 'Recent developments' discusses group codes and several theorems relating to communication rate and the properties of various codes.

The alternation of instruction in statistics with instruction in communication theory is often essential in a lecture course, but it is less attractive in a book, since one feels that both topics are in consequence dealt with rather narrowly.

D. A. BELL

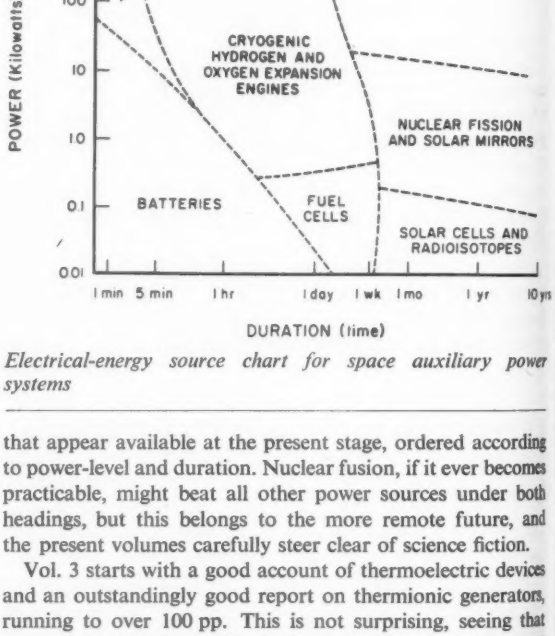
PROGRESS IN ASTRONAUTICS AND ROCKETRY—Vols 3, 4 and 5

M. SUMMERFIELD (*Series Editor*)

NEW YORK: ACADEMIC PRESS. 1961. VOL. 3: 779 pp., £2 18s. VOL. 4: 632 pp., £2 8s. VOL. 5: 579 pp., £2 6s.

THESE three massive volumes are reports of two conferences of the American Rocket Society, one at Santa Monica in September 1960 and the other at Monterey in November 1960. They are rather overwhelming proofs of the speed of modern research; one could even say 'crushing' were it not for the mitigating fact that, when the same research project is tackled in six or more laboratories in parallel, there are bound to be many repetitions. If these could be subtracted, the three volumes would melt down to about one—but it would take a good year's work for the most energetic editor to do this!

The first two volumes are devoted to the power problem in rockets, the third to the new problem of ionic propulsion. The diagram shown (which is taken from Vol. 5, Fig. 3, p. 573) gives a good bird's-eye view of the power sources



Electrical-energy source chart for space auxiliary power systems

that appear available at the present stage, ordered according to power-level and duration. Nuclear fusion, if it ever becomes practicable, might beat all other power sources under both headings, but this belongs to the more remote future, and the present volumes carefully steer clear of science fiction.

Vol. 3 starts with a good account of thermoelectric devices and an outstandingly good report on thermionic generators, running to over 100 pp. This is not surprising, seeing that most of the work in this line in the United States was financed with a view to space applications. There are two almost equally good chapters on photovoltaic cells and electrochemical (fuel) cells, a chapter on mechanical convertors, one on m.h.d. generators and one on electrostatic generators, all with contributions by the best authors. On the whole, this volume is perhaps the best up-to-date survey of these rapidly developing new fields.

Vol. 4 has as its subject power systems for space vehicles, most of which contain the devices discussed in the previous volume. The two main chapters are on solar systems and nuclear systems. Both contain many ingenious ideas, but a really satisfactory light-weight high-power system has not yet evolved.

Vol. 5 is the first comprehensive survey of a completely new technique: ionic propulsion for very fast space vehicles. At first sight this seems to border on science fiction, because the thrust of an ion jet of 1 kW power leaving the nozzle at the relatively low speed of 10^7 cm/s is only 2 g. Hence, massive generators with hundreds of kilowatts ought to be embodied in even small space-probes; but there exists no other method by which matter could be ejected at, say, ten times Sputnik speed. It is understandable, therefore, that in the last three years a great effort has been spent in the United States on high-power ion guns, with neutralization of the ejected space-charge by electrons. This proved to be a surprisingly difficult problem, owing to certain inherent instabilities when ion and electron streams move together. The reader who is new to the subject may be recommended to read first the summary by Seitz, Shelton and Stuhlinger, on the present status of the beam-neutralization problem, before turning to the other 30 articles, which contain an almost overwhelming mass of experimental and theoretical detail.

No progressive research laboratory can afford not to have these three books on its shelves. D. GABOR

FOUNDATION FOR ELECTRIC NETWORK THEORY

M. B. REED

NEW YORK: PRENTICE–HALL. 1961. 354 PP. £3 3S.

THIS book is very much in accordance with the trend of the times and should be welcomed by a large number of electrical engineers and physicists. In subjects such as network theory, which are rapidly developing and becoming of ever increasing importance and scope, there is an immense accumulation of past knowledge—a point made in the foreword by J. D. Ryder, Dean of the College of Michigan State University. This presents a difficult problem to the student, and the solution is 'the consolidation of past specific knowledge and methods into broad areas, and the development therefrom of fundamental disciplines suited to many specific areas and problems'. This is, of course, the proper task for a textbook. In Britain such tasks have been magnificently done in the past by such men as Rayleigh, Todhunter, Routh and many others.

The present volume avoids the need for operational calculus or the Fourier integral (or any other means of extending the scope of fundamental circuit theory to include stored-energy problems) by simply confining itself for the time being to direct current. Strangely enough, this limitation is a positive step, because it makes the text accessible to those who have not yet mastered advanced mathematics without in any way detracting from its value for those who have. The student will find that there is a price to pay for what he will gain from this book, and that is some hours of basic study of such things as segs, trees, nodes, meshes and branches, not to speak of a small consideration of matrices. All the required basic study, however, is here presented from the elements. As stated in the foreword, the investment of time in such basic studies is becoming more and more necessary to the electrical engineer and the physicist. C. G. MAYO

THE PHYSICAL THEORY OF TRANSISTORS

L. B. VALDES

McGRAW-HILL. 1961. 370 PP. £4 1S. 6D.

THIS is intended as a 'textbook for a graduate course in the hybrid field called transistor physics'. It is divided into three parts.

In part 1, dealing with introductory concepts, a simple description is given of diodes and transistors and the materials used to make them. Compared with the other two parts this section is deceptively simple, but it provides a useful introduction to such terms as lattice defects, dislocations, extrinsic semiconductors, donors and acceptors, lifetime and mobility.

Part 2 discusses the electronic properties of semiconductor materials, starting with electron energies and distributions and working up, through Fermi levels, conservation and motion of charge, and mobility and lifetime of electrons and holes, to current flow in semiconductors and the theory of *p–n* junctions. The treatment is thorough and largely mathematical. The part ends with two useful chapters, one describing thermoelectric, optical and magnetic effects and the other giving an introduction to surface properties. Those who find the mathematical treatment of the earlier chapters rather hard going will find these two chapters easier to understand.

Part 3 is entitled 'Properties of semiconductor devices' and relates the physical equations derived in part 2 to the electrical properties and equivalent circuits of diodes and transistors, with a final small chapter on special structures and other factors affecting transistor performance. The majority of part 3 is devoted to the small-signal equivalent circuit of the transistor and only a small part of it to the pulse or large-signal equivalent circuit. The special structures in the last chapter are dealt with extremely briefly, and one could say that the text examines only the *p–n*, *p–n–p* and *n–p–n* structures.

Throughout, references are given to other works on the subjects considered. This should prove a useful book for engineers who wish to delve deeply into the physical properties of semiconductor materials and devices.

E. WOLFENDALE

LEHRBUCH DER HOCHFREQUENZTECHNIK—Vol. 1

F. VILBIG

FRANKFURT AM MAIN: AKADEMISCHE VERLAGSGESELLSCHAFT mbH. 5TH EDITION. 1960. 949 PP. DM48

THE volume is divided into seven chapters. The first deals with fundamental electrical principles, direct and alternating currents, waves, network laws and the properties of circuit-elements, and uses C.G.S. units. Circuit theory is continued in Chapter 2 with a very complete treatment of oscillatory and coupled circuits, filters and transformers, as well as of circuits with varying parameters. Chapter 3 deals with lines, inductance loading, waveguides, cavities, directional couplers, etc., while in Chapter 4 is an exhaustive treatment of the

Some recent books (continued)

propagation of electromagnetic waves in free space and of the behaviour of waves in the various wavelength ranges. A short section at the end of this chapter discusses electromagnetic waves in water.

The remaining chapters cover aerials, interference and electron tubes respectively. Most types of aerial, horn, slot and lens, are discussed, and the principles of radar are introduced. All kinds of natural and man-made interference are described, as well as methods of combating them. The treatment of electron tubes, while just as detailed as the rest of the book, is less up to date, since none of the valves using transit time is dealt with.

The appendixes, related to the appropriate chapters, deal with correlation theory, operational methods of solving differential equations, reflections from the Moon etc., stray radiation in the ionosphere and the troposphere, the influence of the Van Allen radiation belt, Yagi aerials, and additional information on interference.

The treatment throughout is lucid, and practical aspects have not been neglected, but the author has not hesitated to employ mathematics appropriate to the task of detailed exposition. To make full use of all parts of the volume, the student will eventually need an adequate mathematical background, including vector analysis. For the student thus equipped, or one who is pursuing an appropriate parallel syllabus, this excellent book provides a complete course in the physics of telecommunication. It is profusely illustrated and adequately indexed. W. G. STRIPP

OBITUARY

Obituaries of Honorary Members, Members and Companions only are published in the Journal

PATRICK JOHN EGERTON EDGECOMBE

Patrick John Egerton Edgecombe who was born at Kingston, Surrey, on the 15th March 1907 died on the 28th April 1961. He was educated at Wimbledon College and in 1925 became a pupil at Barnes Corporation electricity works, where he gained experience in all departments. In 1928 he transferred to the Kingston undertaking, where he became deputy engineer in 1935.

He was a keen and enthusiastic member of the Territorial Army and in 1928 was commissioned in the Surrey Group Anti-Aircraft Searchlight Company, Royal Engineers. He attained the rank of major and received the Efficiency Decoration.

In 1944 he joined the engineering staff of S.H.A.E.F. as a staff officer, specializing in electrical power supply. He was posted to the S.H.A.E.F. mission to the Netherlands, where he was in charge of the rehabilitation of electrical supplies. In recognition of his services to the Netherlands he was awarded the decoration of the Order of Orange Nassau and appointed an Officer of the Order of Leopold II.

After demobilization he returned to Kingston and later became deputy manager, Kingston District, South Eastern Electricity Board.

He was unmarried and lived with his sister at Kingston.

He joined The Institution as a Student in 1928 and was elected a Graduate in 1935, an Associate Member in 1936 and a Member in 1954. C. S. D.

SYDNEY HENRICK HEMSLEY

Sydney Henrick Hemsley, B.SC., who died on the 6th July 1961 after a long illness was born on the 8th November 1901. He obtained his technical education at Victoria University, Manchester, where he gained a B.Sc. honours degree in electrical engineering; and after initial experience with Ferranti, with Metropolitan-Vickers Electrical Co., Manchester, and with Bruce Peebles, Edinburgh, he joined the transformer design staff of Fuller Electric Ltd. in 1936, the company being then associated with the Swedish Company ASEA.

He resigned in 1945 to take up a senior position on the staff of the *Electrical Times*, with whom he remained three years before forming his own company, Fraser Speller Transformers Ltd., specializing in high-quality static electrical equipment, much of it for the Air Ministry and other Service Departments. He also made an extensive study of foreign languages and wrote many articles for the technical Press, as well as reviewing articles in foreign journals.

During his lifetime he made many friends in the electrical world. For his relaxation he was very interested in colour photography and took during his holidays abroad many pictures, which were finished with the same meticulous care that distinguished all his professional activities. He was also very fond of classical music and attended many concerts. He is survived by his widow.

He joined The Institution as a Student in 1923 and was elected an Associate Member in 1927 and a Member in 1947. He was a Member of the American Institute of Electrical Engineers and an Associate Member of The Institution of Mechanical Engineers. A. J. H./J. E. E.

JOHN INNES

John Innes, C.B., B.SC.(ENG.), who died on the 16th August 1961 was born on the 11th December 1888. He was educated at the Royal High School and part-time at Heriot–Watt College, Edinburgh, being apprenticed to the borough engineer's department of Edinburgh Corporation.

He entered the Post Office Engineering Department in 1913, having previously been engaged as a draughtsman and inspector with H.M. Office of Works, Edinburgh, and became assistant engineer-in-chief in 1935 and director of the Inland Telecommunications Department in 1940. During the Second World War he transferred to the Ministry of Fuel and Power, where he became deputy secretary in 1945.

Returning to telecommunication, he was managing director of Cable and Wireless from 1947 to 1950 and a director of the Telegraph Construction and Maintenance Co. from 1950 to 1959.

He insisted on clear English and abhorred civil service and engineering jargon. He was kindly and most encouraging to junior colleagues, took the trouble to explain why he required any amendments to their drafts and so trained them in clearer exposition.

Golf was his major hobby. His first wife, by whom he had a son, predeceased him in 1932, and he is survived by his second.

He joined The Institution as an Associate Member in 1929 and was elected a Member in 1932. He was appointed a Companion of the Bath in 1942. J. B.

CYRIL ARTHUR MASON

Cyril Arthur Mason, B.SC.(ENG.), who died suddenly on the 21st July 1961 was born on the 12th September 1907. He was educated at Northampton Town and County School and apprenticed to the British Thomson-Houston Co., Rugby, during which time he studied at Rugby Technical College for a B.Sc. degree of London

University, which he gained with honours in 1929. On the completion of his apprenticeship in 1930, he joined the B.T.H. Research Laboratory.

In the laboratory he worked on sound-reproduction problems and soon specialized in acoustics, noise and vibration measurements. In 1939 he became head of a small film laboratory attached to the Research Laboratory, engaged on the production of technical training films for the Services. In 1942 he became responsible for the development, in conjunction with the Admiralty, of anti-submarine proximity devices; he also worked on radar. At the conclusion of the war he reverted to his main interest and was appointed section engineer in charge of the acoustical section of the electronic engineering department. In this position, in addition to being responsible for the design of equipment for vibration measurement and calibration, he acted as consultant to the company on all the company's products where vibration, noise or any problem involving harmonic analysis was concerned. On these and allied subjects, he was the author of a number of technical articles and papers.

In 1954, while on a visit to South Africa, he had a cerebral haemorrhage, which left him partially paralysed. Nevertheless, he still remained available for consultation.

Those who were privileged to know 'Cyril' as a friend realized that behind a somewhat aloof manner he was always willing to help if it was in his power to do so. His enthusiasm for his work knew no bounds. He is survived by his widow and two sons.

He joined The Institution as a Graduate in 1930 and was elected an Associate Member in 1935 and a Member in 1947. He was awarded a Wireless Section premium for his paper written jointly with J. Moir entitled 'Acoustics of cinema auditoria', which was published in the *Journal* in 1941. E. S. H.

BINOY BHUSHAM RAY

Binoy Bhusham Ray, M.B.E., M.SC.(ENG.), who died on the 21st December 1960 was born on the 30th October 1907. He was educated at the Government School, Ranchi, and obtained a B.Sc. honours degree in physics at the University of Calcutta and B.Sc. and M.Sc. degrees in electrical engineering at King's College, London. He received his practical training with the British Thomson-Houston Co., Rugby.

He returned to India in 1937 to take up an appointment as senior engineer with Associated Electrical Industries (India) Ltd., Calcutta, being mainly engaged on sound-reproducer and voltage-regulator work and electromedical-apparatus sales and service.

In 1940 he joined the Government of Orissa, Cuttack, as electrical inspector and adviser, responsible for the creation and organization of the electrical department and for carrying out surveys of hydro-electric development in the province. In 1957 he joined the Vitro Engineering Co. of the United States, consultants to Fertilizer Corporation of India Ltd. He was with the company as a project engineer until 1959, when he joined the corporation as deputy chief maintenance engineer. He was due for promotion to the position of chief engineer in February 1961.

His chief hobby was big-game hunting, and in his rooms at Nangal were skins of leopards, bears, antelopes, etc. that he had collected in Orissa jungles. He was an extremely hard-working and conscientious person and a sincere friend. His death can be partly attributed to overwork. He is survived by his widow, who was English and had completely identified herself with Indian life, so much so that family conversation was practically always in Bengali.

He joined The Institution as a Graduate in 1932 and was elected an Associate Member in 1940 and a Member in 1948. He was appointed a Member of the Order of the British Empire in 1946. H. C. H.

GEORGE FLETT SINCLAIR

George Flett Sinclair, C.B.E., deputy chairman of the Board of Management of British Road Services, who died on the 18th June 1961 at Raynes Park was born on the 14th February 1897. He had been a full-time member of the board since he was appointed to the then Road Haulage Executive in 1950.

He received his engineering education at Robert Gordon's Technical College, Aberdeen, and his engineering training with Dick, Kerr and Co. After three years in France with the Royal Flying Corps during the 1914–18 War and a year with Kilmarnock Engineering Co., he became technical assistant with the English Electric Co.

In 1926 he was appointed general manager of the Kilmarnock Engineering Co., and, in 1930, assistant rolling-stock engineer of London County Council Tramways, becoming rolling-stock engineer in 1932.

When the London Passenger Transport Board was formed in 1933 he became rolling-stock engineer (trams and trolleybuses), and as chief engineer (trams and trolleybuses) from July 1939, with the conversion of tramways to trolleybus operation, played an important part in the design of new trolleybuses. He was appointed deputy general manager (road services) in 1945, after a period from 1940 to 1944 when his services were lent to the United Kingdom Commercial Corporation for special duties in the Middle East.

In 1947 he was appointed chief technical planning and supplies officer, London Transport Executive. In 1948–49 he reported, with a small party, on tram and bus services in the Sydney and Newcastle areas of Australia. He was a former member of council of the Institute of Transport and a former chairman of its Metropolitan Section. He was also a past-chairman of the Public Transport Association.

He had a strong, attractive personality and a tremendous capacity for making friends; he relished hard work, but could also enjoy leisure, being as enthusiastic in the dancing of a Scottish eightsome reel or in a keenly contested game of golf with friends as over the design of a new type of tramcar or trolleybus.

He joined The Institution as an Associate Member in 1931 and was elected a Member in 1938. He was awarded an Institution premium for his paper 'The trolleybus', which was published in the *Journal* in 1940. E. G. M.

JOHN GEORGE ALEXANDER SUTHERLAND

John George Alexander Sutherland who died in Cornwall on the 17th June 1961 was born on the 14th November 1896. He was educated at Cornwall County School, Fowey, and received his electrical engineering education from Mr. H. Nimmo and his practical training with the Great Western Railway Co. at Fowey harbour works and power station. In 1915 he joined Burroughs Wellcome and Co., Dartford, in the electrical engineering department.

He served as a marine engineer during the 1914–18 War and in 1919 joined United Engineers Ltd., Singapore, as an electrical engineer and gained rapid promotion to manager of the electrical division. He also served as a director of the Sarawak Electricity Supply Co., an associate company, and advised the Sarawak Government on the installation of small power stations throughout that country.

He escaped from Singapore before the capitulation and returned to England, where he served in the Ministry of Supply from 1942 to 1945.

On the surrender of the Japanese in 1945, he immediately returned to Singapore as acting managing director of United Engineers and was responsible for the rehabilitation of that organization until the staff who had been interned returned from recuperation leave. He finally retired to England in 1947, on account of ill-health, but continued as London director of United Engineers until his death.

He was an early radio enthusiast, a founder member of the Malayan Amateur Broadcasting Society, and the first to own a Malayan broadcasting licence.

He is survived by his widow.

He joined The Institution as an Associate Member in 1929 and was elected a Member in 1937. C. B. Y.

FRANCOIS PETRUS VILJOEN

Francois Petrus Viljoen, B.SC., who was born in the Cape Province, South Africa, on the 24th April 1894 died on the 24th April 1961.

He was educated at Britstown Public School, Cape Province, and at the South African College, Cape Town. He served in the 1914–18 War and afterwards obtained a B.Sc.(Eng.) degree.

He joined the Victoria Falls and Transvaal Power Co., Johannesburg, in 1923 and the Public Works Department of the Union Government of South Africa two years later.

In 1935 he joined the consulting engineers, Viljoen and Keyter, as a partner.

He was a Member of the Association of Consulting Engineers (Incorp.), of the South African Association of Consulting Engineers, of the South African Institute of Electrical Engineers, and of the Institution of Heating and Ventilating Engineers, and an Associate Member of The Institution of Mechanical Engineers.

He was first and foremost a family man, a man of high principles, respected by all, kind-hearted and devoted to duty. He is survived by his widow and two daughters.

He joined The Institution as an Associate Member in 1936 and was elected a Member in 1944. H. R. K.

TECHNICAL PUBLICATIONS

FURTHER information and copies of the publications can be obtained from the organizations concerned, except where otherwise stated in a footnote

BRITISH BROADCASTING CORPORATION

Engineering monograph no. 35 **Tables of horizontal radiation patterns of dipoles mounted on cylinders** by P. Knight and R. E. Davies. London, 1961. 5s.

TABLES of the horizontal radiation pattern of a dipole mounted on a cylindrical mast are contained in this monograph. A comprehensive range of mast sizes and dipole spacings is covered.

Engineering monograph no. 38 **Operational research on microphone and studio techniques in stereophony** by D. E. L. Shorter. London, 1961. 5s.

THE B.B.C. carried out a series of operational experiments in order to gain practical experience in stereophony as applied to broadcast programmes. The conclusions reached are discussed in the monograph. Sufficient experience was gained to serve as a basis for the detailed planning of future stereophonic studios, control equipment and programmes.

BRITISH ELECTRICAL AND ALLIED INDUSTRIES RESEARCH ASSOCIATION

40th annual report for the year ended 31st December 1960. Leatherhead, Surrey, 1961. n.p.

DETAILS are given of researches carried out by the E.R.A. These include insulation and dielectrics; switch and control gear; power plant; insulated cables; overhead lines; surge phenomena; integrating meters; magnetic materials; transformers; flameproofing and intrinsic safety; earthing, safety and circuit problems; rural electrification; heating, cooking and allied problems; electric equipment of automotive systems; and communication interference. A list of reports published during the year is given.

Report F/T197 **The protection of circuits by miniature circuit-breakers** by H. W. Baxter. 10s. 6d., postage 6d.

THIS report is primarily concerned with thermal effects in the protected cable during the operation of the miniature circuit-breaker in a 250V circuit with currents up to 1500A at a power factor of 0·8.

Report L/T382 **The effects of small discharges on some insulating materials.** III—At temperatures up to 250°C, by N. Parkman. 15s., postage 8d.

THE modes of dielectric breakdown by discharges at temperatures up to 250°C, the evaluation of some materials for use in the presence of discharges at these temperatures, and the appraisal of a possible standard industrial test for assessing the relative resistances of moulded insulation to the impact of discharges are discussed.

Report Q/T151 **A method based on Maxwell's equations for calculating the axial short-circuit forces in the concentric windings of an idealised transformer** by P. R. Vein. 15s., postage 6d.

A METHOD of predicting, from Maxwell's equations, the large and often destructive axial forces that develop in the concentric windings of a transformer is described in this report. For a given transformer and a given arrangement of tappings, analytical expressions are derived for the compressive forces in terms of the magnetic vector potentials in the two windings. The method of solution is outlined for the general case, and numerical values are computed in two simple examples.

Report Z/T105 **The performance of insulated carbon–resin film resistors—II** by F. G. Rivers. 10s. 6d., postage 6d.

THIS is a continuation of a previous report, Z/T95. It discusses a.c. and d.c. life tests, a.c. overload tests and the effects of heat on its own.

Report Z/T124 **High stability carbon-film fixed resistors** by I. D. L. Ball and R. G. J. Butler. 7s. 6d., postage 6d.

IT is found that in suitable humid conditions leakage paths form between points on the carbon track of high-stability carbon-film fixed resistors when on light d.c. load. Failure is rapid when condensation of water occurs on the resistors and when blemishes exist in the varnish coating.

BRITISH NATIONAL COMMITTEE, WORLD POWER CONFERENCE

Technical data on fuel edited by H. M. Spiers. 6th edition. London, 1961. £3, postage 1s. 9d. (inland) and 2s. (abroad)

DATA required in dealing with fuel problems are presented with explanatory text and notes. Nuclear fuels are included.

BRITISH STANDARDS INSTITUTION

B.S. 173: 1960 **Rotating electrical machines for use on road and rail vehicles.** 10s.

THE electrical performance of rotating electrical machines forming part of the equipment of electrically propelled road and rail vehicles, including those for use in mines, is covered.

B.S. 358: 1960 **Measurement of voltage with sphere-gaps** (one sphere earthed). 6s.

RULES and recommendations for the construction and use of sphere-gaps for voltage measurement, where one sphere is earthed, are contained in this publication. The rules apply to the measurement of the peak values of alternating voltages, full standard impulses and impulses with longer tails, and direct voltages.

B.S. 397: 1960 **Primary cells and batteries.** 15s.

THIS standard covers primary cells and batteries for general industrial and domestic applications and batteries for domestic radio receivers and hearing aids. The designations, nominal voltages, dimensions and performance requirements of primary cells and batteries of the Leclanché and mercury types are specified.

B.S. 448: Sections B8D/3 and 7/3: 1961 **Electronic-valve bases, caps and holders. Section B8D/3** (No title). **Section 7/3—5 and 7 lead-in-line subminiature valveholders and associated gauges.** 3s. each section

THE dimensions for valveholders and for gauges needed to ensure compatibility with the appropriate valves are laid down in these sections. Section B8D/3 applies to holders, and associated gauges, for valves having B8D-type bases; section 7/3 applies to holders, and associated gauges, for valves having 5 or 7 lead-in-line bases.

B.S. 466: 1960 **Electric overhead travelling cranes** for general use in factories, workshops and warehouses. 10s.

CLASSES 2, 3 and 4 a.c. and d.c. electric overhead travelling cranes for general use are covered by this standard. Section 4 gives the electrical requirements.

B.S. 469: 1960 **Electric lamps for railway signalling.** 7s. 6d.

THE technical requirements for railway signalling lamps and the methods of test to be used to determine their quality and interchangeability are stated in this standard.

B.S. 495: 1960 **Lamp caps and lampholders for double-capped tubular lamps.** 3s.

THE principal dimensions of lamp caps and requirements for lampholders for use on double-capped tubular lamps at voltages not exceeding 250 V are specified.

B.S. 546: 1950 **Two-pole and earthing-pin plugs, socket-outlets, and socket-outlet adaptors for circuits up to 250 volts.** Suppl. no. 1 (1960)—Plugs made of resilient materials. 4s.

THE supplement covers plugs made substantially of rubber or other suitable resilient material that are not included in the main specification and relates to 2, 5, 15 and 30 A plugs, fused or unfused.

B.S. 607: 1960 **Concrete poles for electrical transmission and traction systems.** 4s. 6d.

REINFORCED-concrete and prestressed-concrete poles, suitable for use as electrical transmission- and traction-line supports, are covered by this standard.

B.S. 697: 1960 **Rubber gloves for electrical purposes.** 5s.

THE gloves are divided into four classes depending on the maximum voltage to be encountered. The classes are up to 660, 1100, 3300 and 4000 V (r.m.s.) to earth respectively.

B.S. 936: 1960 **Oil circuit-breakers for medium voltage a.c. systems.** 15s.

THIS standard applies to 3-pole oil circuit-breakers that are suitable for 3-phase industrial- and supply-distribution systems having breaking currents not exceeding 43·3 kA and voltages up to 660 V. The circuit-breakers are for use in those parts of the system where marked asymmetry in the short-circuit current cannot occur and where the short-circuit operating-duty requirements and restriking-voltage conditions are not severe.

B.S. 1041: Part 3: 1960 **Code for temperature measurement.** Part 3—Industrial electrical resistance thermometers. 5s.

INDUSTRIAL electrical-resistance thermometers, in which the element is fabricated from commercially pure metal of known electrical characteristics, are dealt with in this part. Some notes are given in an appendix on the use of thermistors.

B.S. 1270: 1960 **Electric discharge lamps for general purposes.** 5s.

THIS schedule gives dimensions, nominal light output, life and other relevant information for discharge lamps that are in general use.

B.S. 2111: Part 1: 1960 **Fixed wire-wound resistors for use in telecommunication and allied electronic equipment.** Part 1—General requirements and tests. 10s.

THIS part gives the requirements and tests for insulated and non-insulated fixed resistors consisting of a winding of resistance wire on a heat-resisting former and having a dissipation not exceeding 200 W at 70°C and a rated resistance value not greater than 200 kΩ. Precision wire-wound resistors are excluded.

B.S. 2133A: Part 1: 1960 **Fixed ceramic dielectric capacitors grade 1 for use in telecommunication and allied electronic equipment.** Part 1—General requirements and tests. 12s. 6d.

REQUIREMENTS and tests for fixed ceramic-dielectric capacitors (grade 1) for r.f. currents not exceeding 1 A or a reactive power not exceeding 200 VAr and with a nominal temperature coefficient not exceeding 1500 parts in 10^6 are given.

B.S. 2971: 1961 **Class II metal-arc welding of steel pipelines and pipe assemblies for carrying fluids.** 12s. 6d.

THE shop and site metal-arc welding of joints in carbon-steel pipelines and pipe assemblies up to and including 24 in. (610 mm) in diameter carrying fluids suitable for Class II conditions is covered by this standard. The standard of workmanship and the standards to which the welds shall conform are also given.

B.S. 3234: 1960 **Polythene insulation and sheath of electric cables.** 4s.

THE composition, physical and electrical requirements, and test methods for polythene insulation and sheath, taken from electric cables after manufacture, are specified. Cellular and irradiated polythene, and polythene with a density greater than 0·93 g/ml, are not covered.

B.S. 3383: 1961 **Normal equal-loudness contours for pure tones and normal threshold of hearing under free-field listening conditions.** 4s. 6d.

THE normal relations existing between sound-pressure level and frequency for pure tones of equal loudness, and the values for the normal threshold of hearing when the source of sound is directly ahead of the listener, are given in this standard for pure tones in the frequency range 20–15000 c/s.

B.S. 2G. 100: Part 3: 1960 **General requirements for aircraft electrical equipment.** Part 3—Characteristics of electrical power systems and equipment. 6s.

THE essential general characteristics of systems for the generation, distribution and utilization of electric power in aircraft are detailed.

Code of Practice CP1011: 1961 **Maintenance of electric motor control gear.** 6s.

THE object of this code is to provide a general record of those matters that experience has shown to be of major importance in keeping motor-control gear in good working condition. The recommendations have been set out in a form that will be of direct use to the maintenance electrician.

BUTTERWORTHS

Automatic and remote control edited by J. F. Coales. London, 1961. 4 vols. £45 the set

THIS set of books contains the proceedings of the first international congress of the International Federation of Automatic Control held in Moscow in 1960. The books provide a very complete coverage of the present state of automatic control.

The introductory and concluding speeches are given in Vol. 1. The four volumes are divided into three parts—'Theory', 'Components' and 'Applications'. Part 1 (Theory) is further divided into 'Theory of continuous linear systems', 'Theory of continuous non-linear systems', 'Theory of discrete systems', 'Theory of optimal systems', 'Theory of self-adjusting systems', 'Statistical methods of investigation', 'Theory of structure and signal composition', 'Special mathematical problems', 'Simulation and experimental methods' and 'Terminology and education'. The part on components is divided into 'Electric and magnetic components', 'Electrical simulation, computing components and governors', 'Components and systems for remote and supervisory control', 'Pneumatic components and computing devices' and 'Automatic control instruments and devices'. Part 3 (Applications) is divided into 'Automation in metalworking', 'Automation of electrical power systems', 'Automatic electrical drives and machines', 'Automation in transport', 'Automation of industrial processes', 'Automation in chemical and oil industries', 'Automatic control of thermal and nuclear power' and 'Automation of metallurgical processes'.

The papers are in English, but the majority of them have summaries in English, French and German. The discussion is printed at the end of the appropriate paper.

DANISH SCIENCE PRESS LTD.

Non-linear distortion and small-signal parameters of alloyed junction transistors by Niels I. Meyer. Copenhagen, 1960. n.p.

THE main subjects covered by this book are non-linear distortion in almost linear networks, with special reference to transistors, and the variation of transistor small-signal parameters with the d.c. working point.

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH and FIRE OFFICES' COMMITTEE, JOINT FIRE RESEARCH ORGANIZATION

Fire research 1960 H.M.S.O., London, 1961. 5s. 6d., postage 5d.

ABOUT 130300 fires were attended by fire brigades in the United Kingdom in 1960. The direct cost, according to *The Times* estimates,

Technical publications (continued)

was about £44 million. Fires due to electricity continued to increase with the increasing consumption of electricity. Studies were made of fires due to electrical apparatus and supply installations. There were 2896 fires reported, of which 44% occurred in dwellings. The largest proportion of fires (about 65%) was attributed to failure of fixed cable or flex. About 6% of the fires in wires and cables were attributed to overloading and about 72% to broken insulation.

ÉDITIONS CHIRON

Les sextils. Nouvelle méthode de calcul graphique by P. Dejussieu-Pontcarral. Paris, 1961. 12NF

THE graphical method described is based on the properties of the equilateral triangle. Applications to electrical problems are given.

ELECTRONIC ENGINEERING ASSOCIATION

A guide to the repair of printed board assemblies. London, 1961. 3s.

THIS booklet lists tools and materials required for the repair of printed-board assemblies and gives repair techniques for the replacement of defective components. Repairing open-circuits in the printed wiring is also covered.

ENGINEERING PUBLISHERS

Static relays for electronic circuits edited by Richard F. Blake. Chapman and Hall, London, 1961. £3 3s.

THE book is based on a static-relays symposium sponsored by the Electronic Components Research Department of the United States Army Signal Research and Development Laboratory. Basic design, properties, characteristics and applications of static relays are discussed. There are chapters on semiconductor switching devices, bistable magnetic-amplifier switches, solid-state analogue switching circuits, tunnel diodes as switches, a transistor sampling relay, and the photo-switch.

FÉDÉRATION PROFESSIONNELLE DES PRODUCTEURS ET DISTRIBUTEURS D'ÉLECTRICITÉ DE BELGIQUE

La production et la consommation d'électricité en Belgique 1960. Brussels, 1961. n.p.

STATISTICS given in this brochure cover all production, transmission, distribution and utilization of electrical energy in Belgium in 1960.

Rapport sur l'activité de la commission de documentation et d'orientation des recherches scientifiques en 1960. Brussels, 1961. n.p.

RESEARCH work undertaken in the electricity industry and by specialist bodies is given in this publication.

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

Informal working bulletin no. 16 **Possibilities for the utilization of solar energy in underdeveloped rural areas** by Gerald T. Ward. Rome, 1961. n.p.

THE bulletin reviews experience gained in solar-energy research during recent years and discusses the practical and economic possibilities of its application in the rural areas of the world that do not have ready access to the conventional sources of power. It is concluded that at the moment it is not practicable for underdeveloped countries to use solar-energy devices.

Informal working bulletin no. 17 **Windmills for water lifting and the generation of electricity on the farm** by E. W. Golding. Rome, 1961. n.p.

WIND power for agricultural work is discussed in this bulletin, which provides mainly practical information for those responsible for power supplies on farms that have little immediate prospect of connection to main power networks or where the difficulty in transporting fuel renders oil-produced power expensive.

FRIEDR. VIEWEG UND SOHN

Mikrowellenröhren edited by J. Wosnik. Brunswick, Germany, 1961. DM210

THE proceedings of the conference on microwave tubes, held in Munich from the 7th to 11th June 1960, are contained in this book. There are 138 papers, 91 in English, 30 in German and 17 in French. The papers are divided among 17 sections. The section headings are 'General papers', 'Klystrons', 'Travelling-wave tubes', 'Backward wave tubes—type O', 'Amplifiers and backward wave tubes—type M', 'Magnetrons', 'Tubes of special design', 'Space-charge waves', 'Slow-wave structures', 'Molecular amplifiers', 'Parametric amplifiers', 'Parametric amplifiers with electron beams', 'Noise', 'Formation and focusing of electron beams', 'Gas discharge', 'Ion oscillations; plasma' and 'Technology'.

H.M. STATIONERY OFFICE

Patents, designs, and trade marks. Seventy-eighth report of the Comptroller-General of Patents, Designs, and Trade Marks, with appendices, for the year 1960. London, 1961. 1s. 6d.

THE Comptroller-General's report shows that in the electrical field there was great activity on semiconductors and devices applicable to xerography. Machine recognition of typewritten and other characters for input to computers also received much attention. Pressure vessels of concrete, and adaptation of reactors for marine use and for earthquake zones, were new lines of development for nuclear reactors.

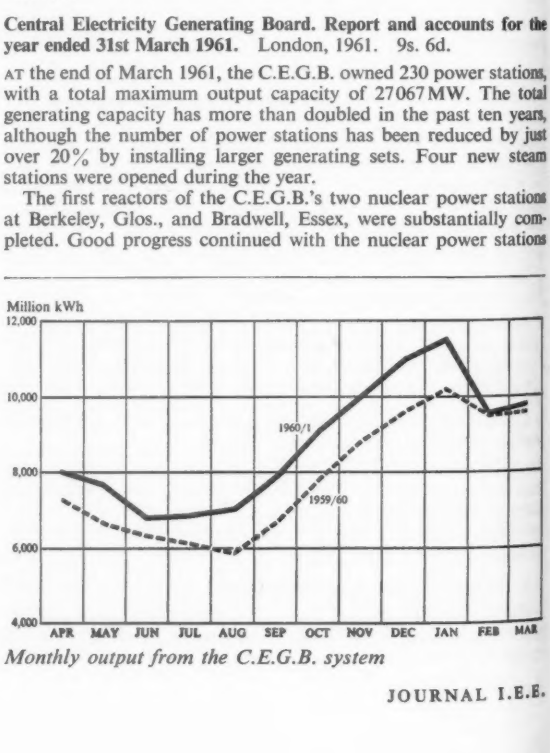
The Electricity Council. Report and accounts for the year ended 31st March 1961. London, 1961. 9s. 6d.

AS well as covering the Electricity Council's functions for the year, the report gives a general view of the activities and progress of the electricity supply industry as a whole in England and Wales. Sales of electricity were 12·1% higher than in the previous year and reached 96053 million kWh. The report devotes a chapter to the generation, transmission and distribution of electricity and one to research.

Central Electricity Generating Board. Report and accounts for the year ended 31st March 1961. London, 1961. 9s. 6d.

AT the end of March 1961, the C.E.G.B. owned 230 power stations, with a total maximum output capacity of 27067 MW. The total generating capacity has more than doubled in the past ten years, although the number of power stations has been reduced by just over 20% by installing larger generating sets. Four new steam stations were opened during the year.

The first reactors of the C.E.G.B.'s two nuclear power stations at Berkeley, Glos., and Bradwell, Essex, were substantially completed. Good progress continued with the nuclear power stations



Monthly output from the C.E.G.B. system

at Hinckley Point, Somerset, and Trawsfyndd, Merionethshire. Contracts were placed for nuclear stations at Dungeness, Kent, and Sizewell, Suffolk. Over 111400 million kWh of electricity were generated in power stations in England and Wales during 1960–61, 10·8% more than in the previous year. At the end of 1961, the Grid system consisted of 7532 route-miles of overhead lines and underground cable (1488 miles operated at 275kV, 5734 at 132kV and the remainder at 66kV or less). New transmission lines due to be commissioned in and after 1965 will be designed for 400kV working. Work continued on the cross-Channel power link.

The new Berkeley Nuclear Laboratories were nearly completed (since opened in May 1961), and the Central Electricity Research Laboratories at Leatherhead were greatly extended.

HILGER AND WATTS LTD.

Digital data by D. S. Evans. London, 1961. 15s.

THE scope of this book is limited to shaft-driven digital devices. There are chapters on incremental scales, digital counting devices, direct reading from coded scales, ancillary equipment, and system arrangements and applications. A short bibliography is given.

INTERNATIONAL ATOMIC ENERGY AGENCY

Directory of nuclear reactors. Vol. 1—Power reactors. Vienna, 1959. 21s. Vol. 2—Research, test and experimental reactors. Vienna, 1959. 21s. Vol. 3—Research, test and experimental reactors (supplement to Vol. 2). Vienna, 1960. 24s.

THE basic criteria for the selection of reactor projects for inclusion in Vol. 1 were that the reactors should be in regular operation and producing electric power of at least 2MW by the end of 1962.

The information about each reactor is presented in a uniform manner. General information; reactor-physics data; core information; sketches of the fuel element or the fuel-element assembly and of the horizontal and vertical sections of the reactor; information on the fuel element, core-heat transfer, control, reactor vessel and over-all dimensions; and fluid flow are given. A simplified flow diagram and information on reflector and shielding, containment and turbogenerator are also included. When available, information on cost estimates and operating staff is given. The description of each reactor ends with general remarks and bibliographical data. The reactors are grouped according to the coolant used in them.

In Vol. 2 details of research, test and experimental reactors have been assembled. Data given are similar to those in Vol. 2. Reactors included were currently in use or under construction. Vol. 3 is a supplement to Vol. 2.

All data contained in the three volumes have been either provided or reviewed by the authorities in the countries concerned.

INTERNATIONAL COMMISSION ON ILLUMINATION

Street lighting and accidents. Paris, 1961 (French/English/German). 15s.*

MANY published studies of accidents have not been made with the necessary rigorous statistical procedures. The connection between street lighting and accidents must be studied rigorously. It has been shown that the provision of good street lighting in previously badly lighted streets has resulted in a reduction in personal-injury accidents of about 30%. Procedures are given for the collection of data on accidents.

INTERNATIONAL COMMISSION ON RULES FOR THE APPROVAL OF ELECTRICAL EQUIPMENT

Publication 19 **Miniature circuit-breakers for domestic and similar purposes.** Nederlands Comité voor de CEE, Arnhem, 1959 (French/English). 12s. 6d.†

THE specification applies to miniature circuit-breakers for use on d.c. or 50c/s a.c. supplies, with a rated voltage not exceeding 440V and a rated current not exceeding 25A, and intended for the protection of wiring in domestic and similar electrical installations where the ambient temperature is between 0° and 40°C.

Publication 20 **Portable motor-operated tools.** Nederlands Comité voor de CEE, Arnhem, 1960 (French/English). 16s.*

PORTABLE electric-motor-operated tools, for indoor or outdoor use, are covered by this specification. Tools that can be used as portable tools are also included.

INTERNATIONAL ELECTROTECHNICAL COMMISSION

Publication 50 (62) **International electrotechnical vocabulary.** Group 62—Waveguides. 2nd edition. Geneva, 1961 (French/English). 18s.*

SOME 152 terms and definitions in French and English, together with the equivalent terms in German, Spanish, Italian, Dutch, Polish and Swedish are given in this group. They are divided into 'Fundamental terms', 'Waveguides', 'Coupling and mode-changing devices', 'Adjusting and measuring devices' and 'Aerials'.

Publication 125 **General classification of ferromagnetic oxide materials and definitions of terms.** Geneva, 1961 (French/English). 20s. 3d.*

AS well as containing a classification of ferromagnetic oxide materials, this publication gives terms and definitions for general use in this field.

Publication 128 **International code for the designation of photographic projector lamps.** Geneva, 1961 (French/English). 13s. 6d.*

A CODING system for the designation of photographic projector lamps, according to the characteristics that affect interchangeability, is described.

The purpose is to provide an internationally applicable and convenient lamp-identification symbol that may be used for manufacturing and ordering purposes.

McGRAW-HILL PUBLISHING CO. LTD.

Writing a technical paper by D. H. Menzel, H. M. Jones and L. G. Boyd. London, 1961. 15s.

THE aim of this book is to give practical help to all who want to write as well as possible about some aspect of science or engineering. Major problems in composition are illustrated by quoting sentences and paragraphs from many publications.

The chapter headings are 'The evolution of a paper', 'Revision', 'Presenting the data', 'Grammar', 'Style', 'Jargon' and 'The physical manuscript'.

MINISTRY OF TRANSPORT

Second interim report on the accidents and failures which occurred in multiple unit electric trains in the Scottish Region and Eastern Region British Railways. H.M.S.O., London, 1961. 1s. 9d.

THE report is mainly concerned with the failures of the electrical equipment in some of the multiple-unit Eastern Region trains. The Eastern Region uses a dual-voltage (6·25/25kV) system. The failures arose primarily on account of the onerous conditions set up when trains were running on the 6·25kV section of the system.

NATIONAL COAL BOARD

Information bulletin 61/223 **Protection of colliery structures against lightning.** n.p.

THE limitations of a single lightning conductor are examined in this bulletin. Alternatives to the single conductor are given, and protection for buildings containing explosives and for tall buildings is discussed.

* Obtainable from the Hon. Secretary, National Illumination Committee of Great Britain, National Physical Laboratory, Teddington, Middlesex
† Obtainable from the Sales Department, British Standards Institution, 2 Park Street, London W.1

* Obtainable from the Sales Department, British Standards Institution, 2 Park Street, London W.1

Technical publications (continued)

NATIONAL PHYSICAL LABORATORY

Notes on applied science no. 22 **Capacitors, inductors and resistors at radio frequencies** by T. I. Jones. H.M.S.O., London, 1961. 1s. 9d.

IMPEDANCE measurements using resonant lines, the dielectric test set of Hartshorn and Ward, and other resonant methods are described in these notes. There are sections on the measurement of very small capacitances, impedance measurements with the N.P.L. r.f. Schering bridge, and refinements in the use of the B.B.C.-type multi-ratio admittance bridge.

Notes on applied science no. 23 **Radiometric standards and measurements** by E. J. Gillham. H.M.S.O., London, 1961. 1s. 9d.

SECTIONS in these notes describe the measurement of total radiation, the measurement of monochromatic radiation and the absolute measurement of radiation.

OAK RIDGE NATIONAL LABORATORY

ORNL—2985 **The feasibility of an unattended nuclear power plant** by M. W. Rosenthal, M. M. Yarosh, C. F. Baes, Jun., and R. C. Robertson. Oak Ridge, Tennessee. $1.75*

THE authors conclude that it is feasible to develop, within four years, a reliable, simplified pressurized-water nuclear reactor for unattended service over a period of one year.

ORGANISATION FOR EUROPEAN ECONOMIC CO-OPERATION

EUROPEAN NUCLEAR ENERGY AGENCY

O.E.E.C. Halden boiling heavy water reactor project. Second annual report. Paris, 1961. n.p.†

THE principal objectives of the Halden project are to obtain experience in the operation of a boiling heavy-water reactor, to gain an understanding of the physics and dynamics that govern its performance, and to develop means of accurate measurement within the reactor core. The report is in six sections, which cover the historical background, reactor design and construction, fuel, reactor operation, safety organization and the research programme. The ultimate design specification of the reactor is 20 MW of heat produced in the primary circuit at a reactor outlet temperature of 250°C.

PERGAMON PRESS

Silicon carbide. A high temperature semiconductor. Edited by J. R. O'Connor and J. Smiltens. London, 1960. £4 10s.

THIS volume contains the proceedings of a conference on silicon carbide held at Boston, Massachusetts, U.S.A., from the 2nd to 3rd April 1959 and sponsored by the Electronics Research Directorate of the United States Air Force Cambridge Research Center. The book is divided into five sections: 'The silicon–carbon binary system', 'The growth of silicon carbide single crystals', 'Silicon carbide as a solid', 'Silicon carbide as a semiconductor' and 'Silicon carbide devices'.

Advances in electron tube techniques edited by D. Slater. London, 1961. £5

THE proceedings of the fifth United States national conference on tube techniques held in September 1960 are given in this book. Topics discussed include electron-tube materials and technology, electron-emission phenomena and cathodes, and internal and external environments and life factors of electron tubes.

British miniature electronic components and assemblies data annual 1961–62 edited by G. W. A. Dummer and J. Mackenzie Robertson. London, 1961. £4

ESSENTIAL data on a wide range of British miniature components and information on the effect of potting resins, shock and vibration, and temperature overload are contained in this book. In general, a 1 in. cube is considered the maximum size for miniature components.

RONALD PRESS CO.

Tensor analysis of electric circuits and machines by L. V. Bewley. New York, 1961. $12

PRESENTED in this book are the essential principles, together with applications, of the matrix-tensor methods of analysis of electric circuits and machines developed by Kron.

SWISS FEDERAL RAILWAYS

The Swiss Federal Railways electrification completed. English edition edited by C. E. Whitworth. 1961. 15s.*

THE whole of the Swiss Federal Railway network is now electrified. The network uses 15 kV a.c. 16⅔ c/s. The book discusses the choice of system; the pioneers of electrification; the stages of electrification from 1902 to 1960; supply of electric power; technical aspects of electric traction; construction of the overhead line; locomotive and coach design; the economics of operation with steam, Diesel and electric traction; etc. The book is well illustrated with photographs and diagrams.

TEMPLE PRESS LTD.

Nuclear Engineering monograph no. 12 **Fast reactors** by R. G. Palmer and A. Platt. London, 1961. 12s. 6d.

AN over-all account of fast-reactor technology is given in this book. Special problems encountered in a reactor, where high burn-up and high power density are economic necessities, are pointed out. An outline of methods of calculation and experimental techniques for predicting the performance of a system is presented, together with a brief account of liquid-metal technology and the prediction of heat-transfer coefficients.

UNITED NATIONS

The situation and prospects of Europe's electric power supply industry in 1959–60. Geneva, 1961. 7s.†

THE consumption of electricity in Europe rose rapidly in 1960, the growth rate generally being in excess of the 8·5% average increase in 1959. It is estimated that by 1975 most European countries will reach an average level of several thousand kilowatt-hours per head. Generating capacity, transmission networks, international exchange of electric power and capital expenditure are other points discussed.

The state of rural electrification in Europe in 1959. Geneva, 1961. 5s.‡

THE general position and development of rural electrification are described. Capital investment, consumption of electric power and development of its uses, and economic effects are discussed.

UNITED STATES DEPARTMENT OF COMMERCE

NATIONAL BUREAU OF STANDARDS

Miscellaneous publication 237 **Research highlights of the National Bureau of Standards.** Annual report, fiscal year 1960. Washington, D.C., 1960. 65 cents§

AN illustrated account of the National Bureau of Standards research and measurement activities for 1960 is given in this publication. Electrical measurements include the absolute measurement of current and resistance.

Radio standards, atomic and radiation physics, and heat are discussed.

* Obtainable from the Office of Technical Services, Department of Commerce, Washington 25, D.C., U.S.A.
† Obtainable from H.M. Stationery Office, P.O. Box 569, London S.E.1

* Obtainable from the Swiss Federal Railways, London Office, 458–9 Strand, London W.C.2, and Ian Allan Ltd., Craven House, Hampton Court, Surrey
† Obtainable from H.M. Stationery Office, P.O. Box 569, London S.E.1
‡ Obtainable from the Sales Section, European Office of the United Nations, Palais des Nations, Geneva, Switzerland
§ Obtainable from the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C.

**Denotes that the publication is also in the Lending Library. The publications cannot be bought through The Institution; the publishers and the prices are given only for the convenience of members*

LIBRARY ACCESSIONS

BOOKS

CHASE, R. L. 621.318.572

Nuclear pulse spectrometry*

New York and London: McGraw-Hill, 1961. pp. viii, 221.
23 × 15cm. £3 6s.

Deals with radiation detectors, linear amplifiers, single- and multi-channel and photographic pulse-height analysers and time analysers, multidimensional analysis and counting losses. It was reviewed in the September 1961 *Journal*, p. 572.

DUMMER, G. W. A., and ROBERTSON, J. M. (*Editors*) 621.38(03)

British miniature electronic components and assemblies data annual 1961–62

Oxford and New York: Pergamon, 1961. pp. 479. 28 × 21·5cm. £4

Includes miniature components up to 1in. cube, but larger items are included when they are the smallest of their type. Resistors up to 0·5W and capacitors up to 1in. body length are listed, but not transistors. British components only have been selected; addresses are given; prices are not shown.

FAGOT, J., and MAGNE, P. 621.396.619

Frequency modulation theory*

Oxford and New York: Pergamon; Paris: Société de Documentation Electronique, 1961. pp. xi, 488.
22·5 × 15cm. £5

Discusses propagation, distortion and noise in f.m. systems, the transmission of multiplex signals, and equipment. To be reviewed.

GREINER, R. A. 621.315.59

Semiconductor devices and applications*

New York and London: McGraw-Hill, 1961. pp. xiv, 493.
23 × 15cm. £4 17s.

Deals in some detail with the physics of semiconductors, with the behaviour and characteristics of transistors, and with their applications. Reviewed on p. 673.

HAINE, M. E. 621.385.833

The electron microscope: the present state of the art*

London: E. and F. N. Spon, 1961. pp. xvi, 282.
22·5 × 14·5cm. £2 15s.

Discusses the optical properties of electron-microscope lenses, the wave theory necessary for a proper evaluation of the resolving power and contrast phenomena, and the theoretical limitations of the resolving power. The design of the equipment is dealt with, after which practical limitations of the electron microscope are explained, together with the important subject of specimen preparation. Reviewed in the September 1961 *Journal*, p. 521.

HAMMOND, S. B. 621.31

Electrical engineering

New York and London: McGraw-Hill, 1961. pp. x, 566.
24 × 17·5cm. £3 8s.

This book, intended mainly for those who are not electrical engineers, deals with the fundamentals and broad principles of electrical machines and electronic equipment for control systems and computers, rather than with practical applications. Frequent use is made of mathematical explanations involving some familiarity with the calculus.

HILSUM, C., and ROSE-INNES, A. C. 621.315.59

Semiconducting III–V compounds*

Oxford and New York: Pergamon, 1961. pp. ix, 239.
23 × 15cm. £3

Atoms from group IIIb of the periodic table combine with atoms from group Vb to form crystalline semiconducting compounds. These are called III–V compounds. This book describes their structure and preparation, their properties and their applications. Reviewed on p. 674.

HURLEY, R. B. 621.316.3

Transistor logic circuits*

New York and London: John Wiley, 1961. pp. xvi, 363.
23·5 × 15·5cm. £4

Deals with binary arithmetic and Boolean algebra, the semiconductor diode and diode logic circuits, minimization of single and multiple switching functions, and semiconductor-triode switches. Logic circuits are discussed, with final chapters on bistable, monostable and astable circuits. To be reviewed.

JENNISON, R. C. 517

Fourier transforms and convolutions for the experimentalist*

Oxford and New York: Pergamon, 1961. pp. vi, 120.
21 × 14cm. 30s.

Emphasizes the importance of the Fourier transforms and convolutions in optics, electronics and aerial design and discusses analogous applications in other fields. It is a qualitative treatment, and diagrams are extensively used to portray and develop the operations discussed. To be reviewed.

KALLEN, H. P. (*Editor*) 681.2

Handbook of instrumentation and controls*: a practical design and applications manual for the mechanical services, covering steam plants, power plants, heating systems, air-conditioning systems, ventilation systems, Diesel plants, refrigeration, and water treatment

New York and London: McGraw-Hill, 1961. pp. ix, 703.
23 × 15cm. £5 16s. 6d.

KREUGER, F. H. 621.317.333

Detection and location of discharges: in particular in plastic-insulated high-voltage cables

Delft: N.V. Nederlandsche Kabelfabrieken, 1960. pp. 161.
24 × 16cm. n.p.

This text in English is based on work done from 1957 to 1960 for a thesis. A survey of existing knowledge is followed by a description of the research carried out. New methods for detecting discharges, including non-electrical methods, are explained.

LINVILL, J. G., and GIBBONS, J. F. 621.314.7

Transistors and active circuits*

New York and London: McGraw-Hill, 1961. pp. xv, 515.
23 × 15cm. £5 12s. 6d.

Develops physical models for transistors, to which are applied the two-port network theory for the solution of transistor circuits by mathematical methods. Reviewed on p. 673.

LIWSCHITZ-GARIK, M., and WHIPPLE, C. C. 621.313.3

Alternating-current machines*. 2nd edition

New York and London: D. Van Nostrand, 1961. pp. xvii, 604.
23·5 × 15·5cm. £5 12s. 6d.

Previously published in 1946, this book has been largely rewritten. It is intended to provide an understanding of the link between the basic

Library accessions (continued)

laws of electrodynamics and the performance characterization of transformers and rotating machines. Part 1, consisting of 49 short chapters, is for more-junior students; while chapters 50–63 are for more-advanced students, engineers and designers.

MOORE, C. K., and SPENCER, K. J. 014 : 043

Electronics: a bibliographical guide

London: Macdonald, 1961. pp. xvii, 411. 24·5 × 18·5cm. £3 5s.

This guide covers the period 1945–59. It is divided into 68 sections, under such heads as ultrasonics and sound-echo-ranging, infra-red, dielectrics and dielectric breakdown, ferrites, cables and wiring. The first section, which is a survey of reference works, includes a bibliography of bibliographies, lists, buyers' guides, handbooks, histories, periodicals and translations.

OATES, J. A. 621.791

Welding engineer's handbook

London: George Newnes, 1961. pp. 292. 19 × 13cm. 21s.

A practical guide to all welding and related processes and equipment.

SCHURE, A. (*Editor*) 621.315.59

Semiconductors and transistors*

New York: John Rider, 1961. pp. vi, 138. 21·5 × 14cm. 24s.

This is an elementary account of the properties of semiconductors and the development and application of the various types of transistor now in use.

SOISSON, H. E. 621.317.7

Electronic measuring instruments*

New York and London: McGraw-Hill, 1961. pp. vii, 352. 23 × 15cm. £2 18s.

Deals with detectors, amplifiers, power supplies, transistors, and meter and recorder movements, with normal voltmeters, ammeters, etc., and with oscilloscopes and more-specialized instruments. To be reviewed.

TERRY, H. 696

Mechanical–electrical equipment handbook for school-buildings: installation, maintenance, and use

New York and London: John Wiley, 1960. pp. xi, 412. 23 × 14·5cm. £3 16s.

The book is intended for the non-technical reader. It is not concerned with design considerations but with the operation and maintenance of plant and equipment in American schools.

WALSH, J. B. 538.56

Electromagnetic theory and engineering applications*

New York: Ronald Press, 1960. pp. x, 286. 23 × 15cm. £3 8s.

This textbook for engineering students presents the essentials of field theory and applies them to distributed-parameter circuits, particularly transmission lines. It covers vector analysis, electrostatics, the static magnetic field, Maxwell's equations, plane waves, energy flow and guided waves, the relation between field and circuit equations, and transmission lines. Reviewed in the May 1961 *Journal*, p. 320.

WILLIAMS, C. A. 629.135

Aircraft instruments*

London: Odhams Press, 1961. pp. 240. 23 × 15cm. 35s.

A modern aircraft has several instrument panels, each containing upwards of 100 instruments and indicators. The purpose of these instruments is explained. Each type, whether mechanical or electrical, for the measurement of pressure, air speed, height, temperature, etc., is described and its accuracy discussed, while a separate chapter deals with testing and test equipment. To be reviewed.

OTHER PUBLICATIONS

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Proceedings of the national telemetering conference 22–24 May 1961, held at the Sheraton-Towers Hotel, Chicago

Chicago: A.I.E.E., 1961. pp. 800. 27 × 21 cm. n.p.

ASSOCIAZIONE ELETTROTECNICA ITALIANA

Rendiconti della 61st riunione annuale dell'A.E.I. Ancona 1960. Fasc. 1–3

Milano: A.E.I., 1961. irreg. pag. 29·5 × 21 cm. n.p.

AUTOMATIC TELEPHONE AND ELECTRIC CO.

The type 32A Mark II selector: B.P.O. 2000-type

London: Automatic Telephone and Electric Co. Ltd., 1961. pp. 28. 28 × 21·5cm. n.p.

INSTITUTE OF PHYSICS

Noise in electronic devices: papers based on material presented at a conference held by the Electronics Group of The Institute of Physics at the Services Electronics Research Laboratory, Baldock, Hertfordshire, on 2nd–3rd October 1959

London: Chapman and Hall, 1961. pp. 100. 25·5 × 15cm. £1 15s.

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS

Secondary cells for British Post Office telecommunications by L. H. Catt. Paper 218

London: Institution of Post Office Electrical Engineers, 1960. pp. 20. 27·5 × 22 cm. 2s. 6d.

Long distance transmission by waveguide—the current state of research and development by F. J. D. Taylor. Paper 219

London: Institution of Post Office Electrical Engineers, 1960. pp. 20. 27·5 × 22 cm. 2s. 6d.

INTERNATIONAL TELECOMMUNICATION UNION

Manual for use by the mobile services. Provisions relating to radiocommunication

Geneva: International Telecommunication Union, 1961. pp. 226. 21 × 15 cm. n.p.

NATIONAL PHYSICAL LABORATORY

Modern computing methods. 2nd edition. Notes on applied science no. 16

London: H.M.S.O., 1961. pp. 170. 25 × 15·5 cm. £1 1s.

ONTARIO HYDRO

Report of visit to U.S.S.R. by delegation from Canadian electric utilities, May 14 to June 2, 1960 by H. P. Cadario and H. A. Smith

Ontario Hydro, 1960. pp. 92. 28 × 21·5cm. n.p.

PLASTICS INSTITUTE

Conference on rubber and plastics in cables, organized jointly by The Plastics Institute and The Institution of the Rubber Industry, and held at The Institution of Electrical Engineers on 1 March 1961

London: The Plastics Institute, 1961. pp. 55. 28·5 × 21·5cm. 15s.

SLATER, D. (*Editor*)

Advances in electron tube techniques. Proceedings of the fifth national conference, September 1960

Oxford: Pergamon, 1961. pp. 235. 28·5 × 22cm. £5

Forthcoming events at Savoy Place

ALL meetings are held at Savoy Place, beginning at 5.30 p.m. (tea at 5 p.m.), except where otherwise stated. The nature of the meeting is indicated by the following key:

ED EDUCATION DISCUSSION CIRCLE
E ELECTRONICS AND COMMUNICATIONS SECTION
I INFORMAL
M MEASUREMENT AND CONTROL SECTION
MED MEDICAL ELECTRONICS DISCUSSION GROUP
O ORDINARY
S SUPPLY SECTION
U UTILIZATION SECTION

After each paper that has now been published is added the month when a summary appeared in the *Journal* under 'The Journal digest: papers to be read', i.e. about the time when the paper was published as a separate. A paper that has not yet been published will be available at least ten days before the meeting at which it will be read. The full list of London meetings is given in the meetings card, which is available on request from the Secretary of The Institution

November 1961

I **20** *Monday* S. J. EMERSON, O.B.E., M.ENG., will open a discussion on 'Electrical accidents and their causes, including the legal aspects'§

M **21** *Tuesday* P. M. CLIFFORD *and* A. FELTON, B.SC.(ENG.), will open a discussion on 'The accuracy and precision required in industrial electrical instrumentation'†

S **22** *Wednesday* A. S. ALDRED, M.SC., PH.D. 'Electronic-analogue-computer simulation of multi-machine power-system networks' (paper 3694S) *synopsis:* October 1961; J. G. MILES, B.SC.(ENG.) 'Analysis of over-all stability of multi-machine power systems' (paper 3715S) *synopsis:* October 1961

O **23** *Thursday* F. C. McLEAN, C.B.E., B.SC., H. W. BAKER, O.B.E., *and* C. H., COLBORN, B.SC. 'The B.B.C. Television Centre and its technical facilities' (paper 3786E) *synopsis:* see p. 672

ED **27** *Monday* G. S. BROSAN, PH.D., B.SC.(ENG.), will open a discussion on 'The 57 effects of an electrical current'* (at 6 p.m., tea at 5.30 p.m.)

M **28** *Tuesday* Section Dinner (at the Café Royal, London, at 7 for 7.30 p.m.)

E **29** *Wednesday* E. WOLFENDALE, B.SC.(ENG.). Lecture on 'Recent developments in semiconductor devices and their applications'†

M **30–1 December** *Thursday–Friday* (in conjunction with the British Nuclear Energy Conference) Symposium on nuclear electronics (all wishing to attend are required to register; forms are available on application to the Secretary of The Institution) (see p. 663)

December 1961

E **4** *Monday* P. J. B. CLARRICOATS, B.SC.(ENG.), PH.D., R. A. WALDRON, M.A., *and* G. H. B. THOMPSON will open a discussion on 'Backward waves in waveguides'†

M **5** *Tuesday* PROF. L. F. BATES, PH.D., D.SC., F.R.S. Lecture on 'Domains and domain patterns'†

ED **6** *Wednesday* G. HEYWOOD, B.SC.TECH., will open a discussion on 'Teaching protective systems'* (at 6 p.m., tea at 5.30 p.m.)

O **7** *Thursday* PROF. M. W. THRING, M.A. Parsons Memorial Lecture on 'Magnetohydrodynamics'‡

MED **8** *Friday* Discussion on 'The Peltier, Hall and Seebeck effects'* (at 6 p.m., tea at 5.30 p.m.)

E **12** *Tuesday* L. LEWIN 'Diversity reception and automatic phase correction' (paper 3584E) *synopsis:* July 1961 (supported by a contribution by J. M. SIDWELL, M.SC. 'A diversity combiner giving total power transfer')

S **13** *Wednesday* (in conjunction with the British Nuclear Energy Conference) J. HENDERSON, C.B.E., M.C., B.SC., G. F. KENNEDY, M.A., *and* K. J. WOOTTON, B.SC., PH.D. 'Electrical aspects of Hunterston nuclear generating station' (paper 3770S) *synopsis:* see p. 672.

U **14** *Thursday* E. R. LAITHWAITE, M.SC., PH.D. Lecture on 'Oscillating machines—synchronous and asynchronous'† (supported by a paper by E. R. LAITHWAITE, M.SC., PH.D., *and* R. S. MAMAK, B.SC. 'An oscillating synchronous linear machine' (paper 3351U) *synopsis:* November 1960)

E **18** *Monday* F. J. D. TAYLOR, O.B.E., B.SC.(ENG.). Lecture on 'Large steerable microwave aerials for communication with artificial Earth-satellites and space probes'†

M **19** *Tuesday* K. G. KING, D.F.H. Lecture on 'The use of controllable semiconductor rectifiers in machine control'†

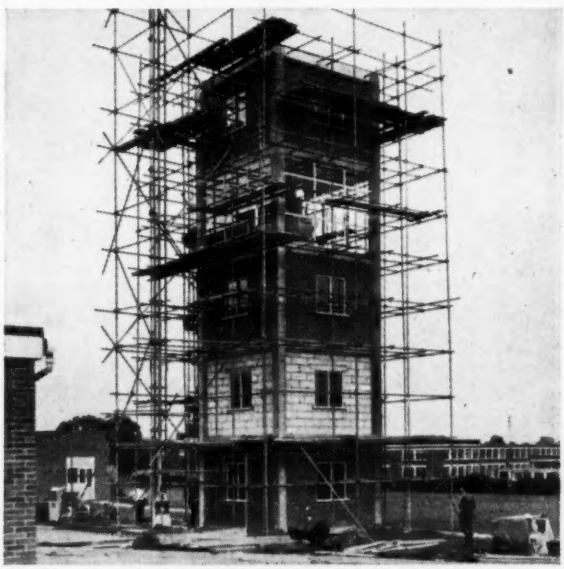
E **20** *Wednesday* R. L. F. BOYD, PH.D., B.SC.(ENG.). Lecture on 'Satellite instrumentation'†

* No advance information will be available, and no Press report will be permitted
† An abstract will be available in advance
‡ No advance information will be available
§ An abstract will be available in advance, but no Press report will be permitted

OVERNIGHT-HEATING FORECASTS

THE British Electrical and Allied Industries Research Association is attempting to relate tomorrow's weather (as forecast) to the number of hours of overnight floor-heating required in a building of known material. To this end, a 5-storey structure is being built, each storey being made of a different building material. The scheme will be of use for large buildings, factories, etc. The Meteorological Office and the British Post Office have promised their co-operation; and, if the work is successful, a coded message could be sent to factories, large buildings, etc., giving settings for overnight-heating controls.

The experimental work is expected to take at least three years and is being carried out with the support of the Electricity Council.



Building at E.R.A. Laboratories for overnight-heating and weather tests

PROBLEMS OF COMMUTER TRAFFIC

MEMBERS are invited to a meeting of The Institution of Mechanical Engineers to hear a Thomas Hawksley Lecture on 'Problems of commuter traffic in conurbations' by Mr. A. Bull. The Lecturer will consider the growth of commuter traffic in large cities (especially London), its implications and planning for the future to deal with it. The meeting will be held at The Institution of Mechanical Engineers, 1 Birdcage Walk, London S.W.1, at 6 p.m. on the 13th December.

Elections and transfers

The following elections and transfers approved by the Council of The Institution are effective from the 2nd October 1961

ELECTIONS *Associate Members*

BAILLIE, Theodore Henry
BLACKWOOD, William
BROWN, Frederick Lorimer, B.SC.
HOGGETT, George James
HOLMES, Lt. John Maxwell Wilson, B.A., R.N.
HOWARD, David Allan, M.A.
JONES, Terence
MARINER, Peter Frederick, B.SC.
PALMER, Sqdn.-Ldr. John Douglas, B.SC.
PHILPOTTS, Geoffrey Clement, B.SC.(ENG.)
ROBERTON, James Samuel Paterson, B.SC.
YULE, Lt.-Col. James De Denne, R. SIGNALS

Associates

DEVITRE, Freddie Phiroze, B.SC.
GOODMAN, Alan Page
LINSLEY HOOD, John Laurence
McNEILL, Colin Alan
MAXWELL, John
MUDIE, Ronald
NAHA, Dakshina Ranjan
SAINT, Harold Henry
WALLWORK, John Vincent

TRANSFERS

Associate Member to Member

BARLOW, George William, B.SC.TECH.
BRADBURY, John James Charles
BULL, Eric William, M.SC.(ENG.)
CAINE, Kenneth Ernest, T.D.
FENECH, George, B.SC.(ENG.)
GREIG, John Charles, B.SC.
HICKIN, Ernest Malcolm
HOWLETT, Cmdr. Peter Vernon Compton, B.SC.(ENG.), R.N.
KEIR, Ronald John, O.B.E., B.SC.
OLDHAMS, Arthur Stanley
PARSONS, Sidney John, B.SC.
PATERSON, Joseph Craig, B.SC.
PITTS, John Patrick, B.SC.(ENG.)
REED, Walter Howard
RUSSELL, John Lithgow
SARWATE, Manohar Balaji, B.SC., PH.D.
SCHOFIELD, Ernest Frederick
SELLS, Capt. Donald Jack
WOLFENDALE, Eric, B.SC.
WRIGHT, Gordon Percy

Graduate to Associate Member

AINSCOW, Peter Frank, B.SC.
ALLAN, James
ARMSTRONG, Thomas Valentine, B.SC.
BALL, Reginald Maurice
BALMFORD, Walter, Jun., B.SC.
BARWICK, Robert Gordon, B.SC.
BAZZARD, George Henry, M.SC.
BEER, Wilfred Charles, B.SC.(ENG.)
BLACK, Thomas Thornton, B.SC.(ENG.)
BOARDMAN, Bryan, B.SC.
BOYES, Stanley
BROWN, Albert Raymond
BUTT, John Arthur, B.SC.(ENG.)
CARTER, James
CHAPLIN, Peter Leigh, B.SC.(ENG.)
CHURTON, James
CLARRICOATS, Peter John Bell, B.SC.(ENG.), PH.D.
COPE, George Stanley
CORNHILL, Gordon Bryan
CROSSLEY, James Ernest
DARKE, James Anthony, B.SC.(ENG.)
DELLER, William Bernard
DEMBECKI, John Adam, B.E.
EDWARDS, Peter Kenneth
ERRETT, John Alfred
EVENS, Ronald Clarence
FREEMAN, Brian Vincent
FRENCH, Arthur George
GRIFFITHS, Howel Martin, M.A.
GRUNER, Lucian, B.E.
HATHAWAY, Kenneth William
HOLMES, Frederick Arthur
ILUMOKA, Emanuel Oladipo
IYER, Kuppuswami Narayanswamy, B.E.
JAMES, Allan, M.A.
JESSANI, Mangho Choithram, B.SC., B.SC.(ENG.)
JEVONS, Morris John, B.SC.(ENG.)
JONES, Cecil Brychan
JUDD, Francis Alfred
KRISHNASWAMY, Sqdn.-Ldr. Bedantadesikan, B.SC.
McCOSH, Andrew Kirkwood, B.A.
McKEAGUE, Roddie, B.SC., PH.D.
MANSON, Charles Joseph
MARSDEN-SMEDLEY, Luke Futvoye, M.A.
MATHEWS, Maurice James Albert
MAYES, Eric
MILLER, Geoffrey Dennis
MILLER, Keith William, B.E.
MILNE, Kenneth Thomas William
MITRA, Asit Kumar, M.SC.
MOULDER, Kenneth
MUKHERJEE, Kesab Chandra, B.E., PH.D.
NICHOLLS, Thomas Alfred
OKORO, Matthias, B.SC.(ENG.)
PIPER, Edward James
PRIMROSE, William Murray, A.H.-W.C.
QUIGGIN, William Stanley, B.E.E.
REES, William John, B.SC.
RICKARD, Justin Roald, B.SC., B.E.
ROBERTS, Peter Taplin, B.SC.(ENG.)
ROBERTSON, Ian Stanley, B.SC.(ENG.)
ROGERS, Maldwyn
SANDERS, Robert George
SAWYER, Rodney Stanley
SEN-GUPTA, Hiranja-Jyoti, B.SC.
SHILLAM, Norman Frederick
SINGH, Bhanu Pratap, B.SC.(ENG.)
SMITH, Wilton Beresford
SOLOMON, Mark Roy
SPURR, Donald
STAINTON, Donald
STEP, Edward Cecil
STEVENS, Robert Desmond
STOCK, Peter Farrer, B.SC.(ENG.)
TAYLOR, Colin Henry
THOMPSON, Christopher Allan
THORNE, Angus
TOMS, Harold Robert
TOWLE, Leonard Christopher, B.SC.
TROLAN, Stanley
TURNBULL, Andrew
TURNER, George Stephen
VANCE, Mervyn Murray, B.SC.
WALKER, Ian Frederick Macey, B.SC.(ENG.)
WARD, John Campbell
WARREN, Edward Jeffery
WENTWORTH, Fitzwilliam Allan, B.E.E.
WILDIG, Norman Raymond
WILLIAMS, Thomas Kenneth
WRIGHT, Raymond
YEOMANS, Kenneth Alfred, B.SC., M.SC.(ENG.)

Student to Associate Member

LAYLAND, Eric, B.SC.TECH.

The following elections and transfers approved by the Council are effective from the 5th October 1961

ELECTIONS *Graduates*

BINGHAM, David, B.SC.(ENG.)
CHEENA, Taibali Taherali
INDULKAR, Chandrasen, M.SC.TECH.
JASINSKI, Kazimierz Mieczyslaw, B.SC.
LEONG, Joseph Woon Wing, B.E.
LUDLAM, Richard, B.SC.(ENG.)
NAR, Ramon
O'DONOGHUE, John, B.E.
OWEN, Bryan Geoffrey

Students

ADAMS, John Brian
BATCHELER, Francis David, B.SC.
BOUTROS, George Zaki, B.SC.
BRADLEY, Philip George
BROWN, Dennis Leslie
BULLOCK, Dennis Arthur
BURNSIDE, John Alastair, B.SC.
BYERS, Graham
DAWSON, Kenneth Richard
DRIVER, John Stanley
EADES, Michael David
FERNANDO, Sumitha Diwasena Ananda Selabhaya
GLYDE, David James Lawrence
GORDON, Geoffrey, B.SC.
GREEN, Peter Eric
HAYLLAR, David John Albert
JACKSON, Lawrence
JONES, Robert John
MUSCAT, Charles Vincent
NEWMAN, David Arthur
PAGE, Alan
PALLANT, Walter Ransome
PATEL, Nagin Khushal
PERERA, Edward Chandrakanthi
PLACE, John Michael
POULTER, Raymond George
POWELL, John Anthony
RAJENDRAM, Sinnadurai
RICHARDSON, David
ROE, John Christopher
SETT, Probir Kumar, B.E.E.
SHINDE, Suresh Ambaji
SIRIWARDENA, Don Leslie Peter, B.SC.
SLADE, Brian Geoffrey
SMITH, Richard Francis
SMITH, Terence Arthur
SPIRA, John Ralph
STAMPER, Henry
SUTCLIFFE, John Apirion Ashton, B.A.
TAYLOR, John Stuart
TUFFS, Barry Cyril
TURNER, Andrew Raymond
WILLIAMS, Martin Ellis, B.A.

TRANSFERS

Student to Graduate

ABAYAGUNAWARDHANA, Kariyawansa Ranaweera Don
ALLAN, Alexander Robert, B.SC., B.SC.(ENG.)
BARKER, Alan Richard, B.SC.
BINES, John Christopher, B.SC.
BIRKIN, Michael Sambrook
CARROLL, Gerard Richard
CHANDLER, Derek Richard, B.SC.
CHANDY, Kallukkattu Varughese
CLARKE, Peter James
COULSON, John Alan
DOWD, Brian William, B.SC.
EGLINTON, Malcolm Oliver
EVEREST, Frank Geoffrey, B.SC.TECH.
FERGUSSON-NICOL, Alexander Emeric
GNANENDRARASAH, Santhiapillai Arulanantham
GUPTA, Salil Kumar, B.SC., B.SC.(ENG.)
HARPER, Donald Jack, B.SC.
HAZLERIGG, Alexander David Grey, B.SC.
HORSLEY, Anthony William, B.SC.(ENG.)
JOHANNESSEN, Rolf, B.SC.(ENG.)
JOLLEY, Anthony Derek, B.SC.(ENG.)
LLOYD, Ronald Henry
LOVESEY, David Alexander, B.SC.(ENG.)
MACDONALD, Quentin John Angus, B.SC.
MARSHALL, Robin Arthur, B.SC.(ENG.)
MEADES, Norman Frederick, B.SC.TECH.
MEIKLE, Hamish Duncan
MICKLEBURGH, David Robert, B.SC.
MITHA, Sadruddin Hasham
NORRIS, Ian Stuart, B.SC.
NYUNT, Kyaw, B.SC.
PARKASH, Gupta Som, B.E.
PATEL, Shashikant Purushottam, B.SC., B.SC.(ENG.)
POPE, Peter James, B.SC.TECH.
RAIF, Faiz Avni
ROE, Robin David
ROGERS, Peter Raymond
SAXTON, David Michael
SOWTER, Brian Raymond, B.SC.(ENG.)
TAIT, George Douglas
THORPE, Laurence Joseph John
TOMASINA, Ronald John Peter
WALLIS, Christopher Norman, B.SC.(ENG.)
WARDELL, Harry Frederick, B.SC.(ENG.)
WEAVER, Peter Stanley, B.SC.(ENG.)
WOODS, John Vivian, B.SC.TECH.
YOUNG, Henry John, DIP.TECH.(ENG.)
YOUNG, William George Wightman, B.SC.

District Meetings

ARRANGEMENTS for District Meetings in November and December 1961 other than in the area of a local Centre

November 1961

READING (at the George Hotel, King Street, at 7.15 p.m.)

20 *Monday* Open forum

CHELMSFORD (at the Lion and Lamb Hotel at 6.30 p.m., tea at 6 p.m.)

28 *Tuesday* E. H. COX *and* R. E. MARTIN, D.F.H. 'Radiocommunication in the power industry'

December 1961

MAIDSTONE (at the 'Wig and Gown' at 6.30 for 7 p.m.)

7 *Thursday* G. P. COPPING, B.SC. 'Electronics in the postal mail services'

ANNOUNCEMENTS TO MEMBERS

THE HOMES FUND

SUMMARY OF CONTRIBUTIONS RECEIVED TO 9TH OCTOBER 1961

	no. of contributors	£	*s.*	*d.*
£1000 and over	8	8685	0	0
£100 to <£1000	32	7181	3	0
£5 to <£100	943	9846	5	10
£2 to <£5	2397	6604	16	3
under £2	31734	16 786	13	10
		£49 103	18	11

NOMINATIONS

B.S.I. COMMITTEE ON ELECTRICAL POWER METERING (ELE/81)

THE Council of The Institution have nominated Mr. A. Felton, MEMBER, who already serves as the representative of the National Physical Laboratory and the Department of Scientific and Industrial Research on the above committee, as their representative in succession to the late Mr. F. Bryne, MEMBER.

B.S.I. TECHNICAL COMMITTEE LGE-6—ELECTRIC LAMPS, AND B.S.I. SUB-COMMITTEES LGE/6/6—ELECTRIC DISCHARGE LAMPS AND LGE/6/7—ELECTRIC DISCHARGE LAMPS (AUXILIARIES)

The Council have nominated Dr. J. W. T. Walsh, O.B.E., M.A., MEMBER, as their representative on the above committees.

B.S.I. SUB-COMMITTEE ELE/3/15—VARNISHED CAMBRIC INSULATED CABLES

The Council have nominated Mr. C. A. Belcher, MEMBER, as their representative on the above sub-committee in place of Mr. J. W. Leach, MEMBER, who has resigned.

CODE DRAFTING COMMITTEES ON RADIO INTERFERENCE FROM IGNITION SYSTEMS (ELCP/14) AND RADIO INTERFERENCE CAUSED BY DISCHARGE LIGHTING (ELCP/15)

The Council have nominated Mr. J. H. H. Merriman, O.B.E., M.SC., MEMBER, as their representative on the above committees in place of Mr. W. J. Bray, M.SC.(ENG.), MEMBER, who has resigned.

COUNCIL FOR THE PRESERVATION OF RURAL WALES—COUNCIL AND EXECUTIVE COMMITTEE

The Council have nominated Mr. D. J. Thomas, MEMBER, as their representative on the above council and committee in place of Mr. J. Vaughan Harries, MEMBER, who has resigned.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, GOVERNING BODY

The Council have nominated Mr. S. E. Goodall, M.SC.(ENG.), PAST-PRESIDENT, as their representative on the above governing body.

BRUNEL COLLEGE OF TECHNOLOGY, GOVERNING BODY

The Council have nominated Mr. D. P. Sayers, B.SC., MEMBER, as their representative on the above governing body.

HENDON TECHNICAL COLLEGE, GOVERNING BODY

The Council have nominated Prof. J. Greig, M.SC., PH.D., MEMBER, as their representative on the above governing body.

ENFIELD TECHNICAL COLLEGE, GOVERNING BODY

The Council have nominated Mr. C. E. Strong, O.B.E., B.A., B.A.I., MEMBER, as their representative on the above governing body.

SLOUGH COLLEGE OF FURTHER EDUCATION, ENGINEERING ADVISORY COMMITTEE

The Council have nominated Mr. A. F. Wilkins, O.B.E., M.SC.TECH., MEMBER, as their representative on the above committee.

SUNDERLAND TECHNICAL COLLEGE, ADVISORY COMMITTEE FOR ELECTRICAL ENGINEERING, MECHANICAL AND MARINE ENGINEERING AND NAVAL ARCHITECTURE

The Council have nominated Mr. W. Gray, MEMBER, as their representative on the above committee.

CITY AND GUILDS OF LONDON INSTITUTE, COMMITTEE ON WORK OVERSEAS

The Council have nominated Prof. M. W. Humphrey Davies, M.SC., MEMBER, as their representative on the above committee.

CHRISTMAS HOLIDAY LECTURE

AT the invitation of the Council of The Institution, Prof. J. M. Meek, D.ENG., MEMBER, will deliver a Christmas Holiday Lecture entitled 'Lightning'. The lecture, which is intended for boys and girls in the fifth and sixth forms, will be given in the Lecture Theatre at Savoy Place on Tuesday, 2nd January 1962, at 3 p.m. and will be repeated at the same time the following afternoon.

Schools in the Home Counties are being invited to apply for tickets, and a number will be reserved for members' children; members should apply for these by the 1st December 1961, stating for which afternoon they are required. As accommodation is limited, members are asked not to accompany their children.

The following is a synopsis of the lecture:

The lecture opens with a discussion of the manner in which electrification occurs in thunderclouds and of the conditions leading to the occurrence of lightning discharges.

Scientific studies of the manner of growth of lightning discharges are described, particular attention being given to

photographic observations with high-speed cameras and to oscillographic and other measurements of the electrical characteristics of lightning. Reference is made to laboratory investigations of the growth of long sparks and the bearing of these results on the interpretation of lightning phenomena.

The damaging effects of lightning are surveyed, and a description is given of means of protection against lightning.

The lecture is fully illustrated with slides and is accompanied by a number of demonstrations. A 100 kV d.c. generator is used to produce electrostatic field effects similar to those occurring when thunderclouds are overhead. Sparks produced by a 200 kV impulse generator enable some of the features of lightning discharges to be simulated.

FLAMEPROOFING AND INTRINSIC SAFETY

THE Committee of the Measurement and Control Section of The Institution are organizing a symposium on flameproofing, intrinsic safety and other safeguards in electrical instrument practice. It will be held on Friday, 27th April 1962. A leaflet giving details of the symposium is being sent with this issue of the *Journal* to members of the Measurement and Control and Utilization Sections. Anyone else may obtain a copy of the leaflet on application to the Secretary of The Institution.

DESIGN AND USE OF MICROWAVE VALVES

A CONFERENCE on the design and use of microwave valves, organized by the Electronics and Communications Section of The Institution, will be held at Savoy Place in September 1963. It is proposed to associate a scientific exhibition with the conference. The date of the conference has been arranged so as not to clash with the series of international conventions on microwave valves, the next of which will be held at Delft, Netherlands, in 1962.

The main purposes of the 1963 conference will be to review microwave techniques and to enable potential users to learn what developments are taking place. In particular, it will provide those in the United Kingdom who are unable to attend international conventions with an opportunity to keep themselves fully informed.

The Organizing Committee, which has been set up under the chairmanship of Mr. A. J. Young, C.B.E., B.SC.(ENG.), MEMBER, invite papers from prospective authors; further details may be obtained from the Secretary of The Institution. More information on the scope of the conference will be issued in about a year's time.

1961 AMENDMENTS TO THE WIRING REGULATIONS

TO take account of recent new and amended British Standards, the Council of The Institution have authorized the issue of Amendments to the Wiring Regulations, to take effect from the 1st November 1961.

The major part of these Amendments is concerned with provisions for the use of armoured p.v.c.-insulated cables to B.S. 3346: 1961, a notable feature of which is the recognition of aluminium conductors (to B.S. 2791: 1956) as an alternative to copper conductors. The use of aluminium conductors of cross-sectional area 0·0225 in.^{2} (7/·064 in.) or less, however, is not recognized for the purposes of the Regulations. The Amendments include tables of current rating for armoured p.v.c.-insulated cables having either copper or aluminium conductors, and installed in air, in underground ducts, or direct in the ground.

The Amendments take account of the revision this year of B.S. 2004—'P.V.C.-insulated cables and flexible cords for electric power and lighting (non-armoured)', which also allows the use of aluminium conductors.

The present year saw the completion of three new British Standards for heat-resisting cable and flexible cord, which together replace the existing B.S. 1327: 1946—'Rubber-insulated asbestos-roved flexible cords'. The new Standards deal with insulation made of silicone rubber, butyl rubber with heat-resisting-fibre layer, and varnished-cambric and heat-resisting fibre; and the new Amendments include appropriate requirements for the choice and installation of these.

In September 1960, progress was made towards the adoption of an international colour code for the cores of flexible cords when, at the 44th Plenary Meeting of the International Commission on Rules for the Approval of Electrical Equipment (C.E.E.), there was unanimous agreement that the earthing core in flexible cables and flexible cords should be identified by a combination of green and yellow. All the 15 member countries of the C.E.E. (i.e. 15 European countries), including the United Kingdom, agreed to recognize this method of identification, either as an alternative to their existing colour code or as their sole national standard.

The 1961 Amendments to The Institution's Regulations now recognize the use of the C.E.E. method as an alternative to the use of the existing national standard colour, green. The C.E.E. have not yet agreed on a standard for the other cores, and red and black continue to be the only colours recognized in The Institution's Regulations for identifying the live and neutral cores.

As a further aid to European standardization, the 1961 Amendments introduce a new definition of the term 'extra-low voltage' that accords substantially with the definition adopted by the C.E.E.

Consideration is being given to changing the relevant British Standards to take account of the above C.E.E. developments.

The Regulations with 1961 Amendments have been approved by the Minister of Power and the Secretary of State for Scotland for the purpose of the Electricity Supply Regulations, 1937.

The Amendments (price 2s. 6d., post-free) may be obtained from the Secretary of The Institution. They should be read in conjunction with the 13th Edition of the Wiring Regulations (1955) with 1958 Amendments. A further printing of the 13th Edition, incorporating both the 1958 and the 1961 Amendments, has been put in hand and will shortly be available at 6s. 6d. per copy, post-free. A completely new edition of the Regulations, the 14th, has been authorized by the Council of The Institution and will be available probably in 1963 (see p. 648).

EDUCATION DISCUSSION CIRCLE MEETING—CHANGE OF DATE

THE London Education Discussion Circle meeting on 'The 57 effects of an electrical current', which is to be opened by Dr. G. S. Brosan, B.SC.(ENG.), will now take place at 6 p.m. on **Monday, 27th November 1961,** and not on Thursday, 23rd November 1961, as previously announced.

CORRESPONDENCE

IN view of the heavy volume of correspondence received daily at the offices of The Institution, it is of the greatest assistance when members, in replying to letters received from the Secretary, quote The Institution's reference number. This saves the time of the routing staff and ensures that a letter not only reaches the department concerned without delay but can be immediately linked with the previous correspondence. It is also helpful when members state their class of membership.

MEMBERSHIP OF LOCAL CENTRES AND SUB-CENTRES

A MEMBER whose registered address is within the area of a Centre or Sub-Centre is automatically attached to the Centre or Sub-Centre concerned and also, if he is a Student or a Graduate under the age of 28, to any Graduate and Student Section within the area. Any member who so wishes, however, may be attached to any Centre or Sub-Centre adjacent to that in which he resides, if this is more convenient to him, by making a request in writing to the Secretary of The Institution.

REGISTER OF MEMBERS—CHANGES OF ADDRESS

MEMBERS are reminded that notifications of change of address should be made to the Secretary of The Institution in London. Where a transfer from the area of one local Centre or Sub-Centre to that of another arises as a result of a change of address, the transfer is automatically arranged by headquarters, and the member concerned need not notify also the Honorary Secretary of the local Centre or Sub-Centre.

To obviate the possibility of errors in the records, members are particularly requested when notifying a change of address to give their full initials, their previous address and their class of membership.

ENGINEERING EDUCATION AND TRAINING

AT a plenary meeting of the Conference of Engineering Societies of Western Europe and the United States of America (EUSEC) in 1958, it was decided to prepare a comprehensive and authoritative report on many aspects of engineering education and training in 19 countries of EUSEC and O.E.E.C.

The required information was obtained by appointing a national reporter for each country. The national report for the United Kingdom was prepared by Dr. B. N. Cole, B.SC.(ENG.), A.M.I.MECH.E., Reader in Mechanical Engineering at the University of Birmingham, who was recommended for appointment jointly by The Institutions of Civil, of Mechanical and of Electrical Engineers.

The engineering societies in each country have been asked to publish their own national reports, as these are complementary to the main EUSEC report and make available more detailed information. This report for the United Kingdom is being published on behalf of the three Institutions and can be obtained from the Secretary, The Institution of Mechanical Engineers, 1 Birdcage Walk, London S.W.1 (price 15s.)

It is hoped that the main EUSEC report, which is being printed on the Continent, will be available shortly; details will be published as soon as possible.

MALTA JOINT GROUP

WITH the approval of the Councils of the three Institutions, a Joint Group has been formed in Malta; the first Committee will consist of these members: *Chairman* A. Attard, M.B.E., M.I.E.E.; *Vice-Chairman* G. Fenech, B.SC., M.I.E.E., A.M.I.MECH.E.; *Hon. Secretary* Cmdr. G. F. C. Ellum, M.I.MECH.E., R.N.(RET.), c/o Bailey (Malta) Ltd., The Docks, Malta; *Hon. Treasurer* P. G. Littlehales, B.SC., M.I.C.E.; and J. G. Edwards, M.B.E., B.SC., A.M.I.C.E.; L. C. Ciantar, A.M.I.E.E.; J. Callagin, A.M.I.C.E.; A. Camilleri, A.M.I.E.E.; A. B. Barbara, A.M.I.E.E.; Lt.-Col. D. R. Mangles, M.B.E., A.M.I.MECH.E., A.M.I.E.E.; and Cmdr. A. H. Stringer, A.M.I.MECH.E.

A programme of meetings and other activities will be announced shortly, and details will be sent to each member with an address registered in Malta. In the meantime, any member wishing for further information about the Group should communicate with the Honorary Secretary, Cmdr. Ellum (address above), or with any other member of the Committee.

ACCURACY OF DIMENSIONAL MEASUREMENT

A SYMPOSIUM on 'Accuracy of industrial dimensional measurements of length and diameter' is to be held at Teddington, Middlesex, on the 17th and 18th April 1962. The symposium is being organized by the National Physical Laboratory in association with this Institution and The Institutions of Mechanical and of Production Engineers.

About 11 papers will be presented, the purpose of which will be both to stress the basic principles to be observed when making accurate measurements of length and diameter and to suggest how existing techniques and measuring apparatus may be applied in accordance with these principles.

WOMEN'S ENGINEERING SOCIETY

THE programme for the 1961–62 session of the London Branch of the Women's Engineering Society includes on the 7th February 1962 a lecture on space communications. On the 5th March Mr. P. S. Carnt will talk on colour television, and on the 7th May Mr. P. F. Mariner will discuss microminiaturization.

Meetings begin at 7 p.m. (tea at 6.30 p.m.) at Hope House, 45 Great Peter Street, Westminster, London S.W.1, and those interested are invited to attend.

THE IONOSPHERE

A CONFERENCE on the ionosphere will be held in London from the 2nd to 6th July 1962 and will cover ionospheric constitution and ionizing radiations, geomagnetism and the ionosphere, irregularities in the ionosphere, and mathematics of wave propagation through the ionosphere. The conference is being organized by The Institute of Physics and The Physical Society.

Contributions are invited and, accompanied by an abstract of 100–150 words each, should be sent to the Chairman of the Organizing Committee, Mr. J. A. Ratcliffe, Radio Research Station, Ditton Park, Slough, Bucks., before the 1st March 1962.

Further particulars will be available at the end of March 1962 from the Administration Assistant, The Institute of Physics and The Physical Society, 47 Belgrave Square, London S.W.1.

INFORMATION PROCESSING AND DIGITAL COMPUTERS

THE International Federation of Information Processing Societies will hold a congress in Munich from the 27th August to 1st September 1962. The congress will cover all aspects of information processing and digital computers, including business-information processing, scientific-information processing, real-time information processing, storage and retrieval of information, language translation and linguistic analysis, digital communication, artificial perception and intelligence, advanced computer techniques, and education. In each category it is planned to cover, where appropriate, the applications of digital computers, programming, systems design, logical design, equipment, and components.

REDUNDANCY TECHNIQUES FOR COMPUTING SYSTEMS

A SYMPOSIUM on redundancy techniques for computing systems will be held on the 6th and 7th February 1962 in the Department of the Interior Auditorium, C Street, between 18th and 19th Streets, N.W., Washington D.C., U.S.A.

The aim of the symposium, which is sponsored by the Information Systems Branch of the U.S. Office of Naval Research, is to focus attention on new ideas and developments that may lead to the introduction of redundancy techniques for future computing systems.

Further information may be obtained from Miss Josephine Leno, Code 430A, Office of Naval Research, Washington 25, D.C., U.S.A.

SOLID-STATE CIRCUITS

A CONFERENCE on solid-state circuits will be held from the 14th to 16th February 1962 at the University of Pennsylvania and the Sheraton Hotel, Philadelphia. The conference, which is sponsored jointly by the Institute of Radio Engineers, the American Institute of Electrical Engineers and the University of Pennsylvania, will include papers dealing with circuit properties, circuit philosophy, and design techniques relating to solid-state devices generally.

Further information is available from Mr. L. Winner, 152 West 42nd Street, New York 36, N.Y., U.S.A.

ELECTRONIC COMPONENTS

A CONFERENCE on electronic components, the sponsors of which include the American Institute of Electrical Engineers and the Institute of Radio Engineers, will be held at Washington, D.C., on the 8th–10th May 1962. The meeting will be devoted to new developments in components, component-processing techniques, component evaluation, and component materials.

The chairman of the Technical Programme Committee is Mr. H. A. Stone, Bell Telephone Laboratories, Murray Hill, N.J., U.S.A.

MICROWAVE THEORY AND TECHNIQUES

A SYMPOSIUM on microwave theory and techniques will be held on the 22nd–24th May 1962 at the Boulder Laboratories of the U.S. National Bureau of Standards, Boulder, Colorado. This is the 1962 national symposium of the Professional Group on Microwave Theory and Techniques of The Institute of Radio Engineers.

The symposium will deal with research, development and applications in all areas of the microwave field, and further information is available from Mr. R. W. Beatty, Chairman of the Technical Programme Committee of the 1962 PGMTT National Symposium, National Bureau of Standards, Boulder, Colorado, U.S.A.

British Nuclear Energy Conference

DETAILS of three forthcoming meetings of the British Nuclear Energy Conference are given below. Papers and discussions on the applications of nuclear energy and ancillary subjects are published in the quarterly *Journal of the British Nuclear Energy Conference*. The annual subscription payable by members of The Institution who wish to receive the quarterly regularly is 30s. post-free. Single copies are available at 7s. 6d. each

1961

NOVEMBER 28 *Tuesday* (5.30 p.m.)

Sponsoring society: Joint Panel on Nuclear Marine Propulsion
Place of meeting: 76 Mark Lane, London E.C.3

HIGH TEMPERATURE GAS-COOLED REACTORS FOR MARINE PROPULSION
J. E. Richards

NOVEMBER 30–DECEMBER 1 *Thursday* (5 p.m.)–*Friday*

Sponsoring society and place of meeting: The Institution of Electrical Engineers, Savoy Place, London W.C.2

Symposium on NUCLEAR ELECTRONICS (see p. 663)

DECEMBER 13 *Wednesday* (5.30 p.m.)

Sponsoring society and place of meeting: The Institution of Electrical Engineers, Savoy Place, London W.C.2

ELECTRICAL ASPECTS OF HUNTERSTON NUCLEAR GENERATING STATION
J. Henderson, C.B.E., M.C., B.SC., G. F. Kennedy, M.A., and K. J. Wootton, B.SC., PH.D.

News from the Centres

WESTERN CENTRE SUPPLY GROUP

Autumn visit

A TOTAL of 78 members and guests gathered from Cardiff, Newport, Bristol, Gloucester and Swindon, and assembled at Temple Meads Station on Saturday, 30th September 1961, to take part in the annual Autumn visit.

The programme included a visit to the Long Ashton Research Station of Bristol University, which was established in 1903 as a National Fruit and Cider Institute to carry out experiments in cider making and fruit culture. Today the Station is administered by the Agricultural Committee of the University of Bristol, the Agricultural Research Council, the Ministry of Agriculture, the County Councils of Somerset, Gloucester and Wiltshire, and other associations. The Station studies all aspects of fruit and willow culture, the manufacture of cider and fruit juices, and the domestic preservation of food. Research is organized into sections of pomology and plant breeding, nutrition of fruit plants, organic chemistry, physical chemistry, entomology, etc., so the party expected to have plenty to think about.

Champagne perry appreciated

On the day before the visit, the meteorological officer of the Station had predicted fine weather, but, to the horror of the assembly, it was raining in the morning. Nevertheless, a jolly party arrived at Long Ashton at 10.30 a.m., to be greeted by the Director, Prof. H. C. H. Kearns. Coffee was served, and by this time the sun began to peep through rather ominous clouds. We learned from the meteorological officer that his alarm clock had been a little late that morning; consequently his influence had also been behind the time.

Skipper Bird thought that the best plants to be seen were about two dozen grey hens that were standing ready for shipment. Dudley Morgan observed, when gazing at a tree, 'Just like mine—no apples, no leaves'. It was a pear tree!

After a fascinating morning, lunch was served in the refectory and, after lunch, coffee in the lounge. The Long Ashton champagne perry made some of the members feel disposed to lounge a little longer; but, after being stirred up, the party arrived at Cheddar Caves, where an hour was spent viewing stalactites and stalagmites and their reflections in water, aided by that modern scientific achievement, electric light.

Farewells were said at 6 p.m., when the party from the north side of the Bristol Channel departed and other members left in their cars.

A. H. McQ.

Culture study at Long Ashton

SCOTTISH CENTRE

Electronics in action

THE 1960–61 Session ended in a blaze of enthusiasm from the recently-formed Electronics and Measurement Group, which, having held 12 meetings and a week-end symposium during its first year of life, organized a three-day 'Electronics in action' exhibition in the Royal Scottish Museum, Edinburgh, on the 28th–30th September 1961 from 10 a.m. to 9 p.m. each day. The exhibition was supported by the various important electronic-equipment manufacturers in the East of Scotland, the Post Office, the British Broadcasting Corporation, the North of Scotland Hydro-Electric Board and the National Engineering Laboratory, together with the electrical engineering departments of the University of Edinburgh and the Heriot–Watt College.

Purpose of the exhibition

The main purpose of the exhibition was to let the general public see electronic apparatus working on everyday tasks and to show how many firms and other establishments in Scotland were engaged in this branch of the electrical engineering industry. Between 5000 and 6000 visitors saw the exhibition, and all concerned spoke very highly of the great interest shown, not only by scientifically minded adults but also by a large number of senior schoolchildren. Most of the organization was carried out by Mr. J. Stewart, Chairman, and Mr. G. I. Thomas, Committee member, of the Electronics and Measurement Group; and the Scottish Centre is very grateful to these and other members of the Group whose initiative resulted in so successful a venture.

Opening meetings

At the Opening Meeting of the 1961–62 Session in Edinburgh on the 3rd October 1961, the retiring Chairman, Mr. R. B. Anderson, presented a Kelvin premium to Mr. W. Farrer, part-author of the paper 'Brushless variable-speed induction motors using phase-shift control' (subsequently read before the Sub-Centre on the 7th November 1961) and a Graduate and Student Section premium to Mr. K. von Krogh for his paper 'Brain waves', presented as his Chairman's Address to the South-East Scotland Graduate and Student Section.

Thought-provoking Address

Mr. Anderson then introduced the new Chairman, Prof. E. G. Cullwick, Watson-Watt Professor of Electrical Engineering at the University of St. Andrews. For his Chairman's Address, Prof. Cullwick spoke on 'Pure and applied science'. With an occasional 'debunking' of certain high authorities, Prof. Cullwick explained very clearly the aims of a university course in electrical engineering, examined possible reasons why many potential graduates approached the engineering profession through science courses, and set forth a number of ideas, some already being carried out in his own department, for rectifying the situation.

In accordance with Scottish Centre precedent, the Address was repeated on succeeding evenings in Glasgow, Dundee and Aberdeen.

E. O. T.

A new appointment at Savoy Place

THERE are at present ten local Centres, 12 Sub-Centres, 13 specialized Groups and 19 Graduate and Student Sections; their number and the scale of their activities increase year by year. To meet the growing needs of these local units, the post of Local Centres Officer has been created on the staff of the Secretary of The Institution; it will be filled by Mr. L. H. Cullingford.

Mr. Cullingford will be available at all times to assist and advise the local Committees, particularly their hard-working Honorary Secretaries. The new arrangement will improve the attention that is always given at Savoy Place to the smooth running of this very important part of the structure of The Institution.

LONDON REPORT

DISTRICT MEETING AT CHELMSFORD

RED-LETTER DAY FOR CHELMSFORD

THE 3rd October 1961 was a red-letter day for members living in the Chelmsford area, when the inaugural District Meeting was held at the Lion and Lamb Hotel. Notices had been sent out to over 500, and more than 200 members and guests gathered in the magnificent setting provided by the Grand Hall. There was ample space at the further end to meet informally over refreshments and to patronize the bar before the meeting proper began at 6.30 p.m.

History of District Meetings

The special occasion was marked by the presence of Sir Hamish D. MacLaren, the Immediate Past-President, and

Dr. A. Hewish lecturing on 'Large radio telescopes'

the Secretary, Mr. W. K. Brasher, who were introduced by Mr. B. N. MacLarty, the convener of the meeting. They gave the history of the establishment of District Meetings, first in the local Centres and then in the outlying parts of the London area and were delighted with the response shown by such a large attendance, including many young people, which augured well for the success of future meetings.

Mr. MacLarty then called on Mr. G. Millington to introduce the lecturer. In inviting Dr. A. Hewish to give his lecture on 'Large radio telescopes', Mr. Millington mentioned that Dr. Hewish was working at the Mullard Observatory and the Cavendish Laboratory, Cambridge, and that he had recently been elected a Fellow of the new Churchill College. An article based on the lecture and with the same title appeared in the October 1961 *Journal*, p. 593.

Large radio telescopes

In the course of an excellent lecture, Dr. Hewish explained that it was better to build a number of telescopes for specific tasks than a single general-purpose instrument. He discussed the requirements for resolving power and sensitivity and showed that, with a system of aerials of the Mills-cross type, it was possible to obtain an effective aperture much larger than was practicable with a single parabolic reflector.

He ended his lecture with a description of the principle of aperture synthesis, which was being used successfully at Cambridge, in which one arm of a Mills cross was replaced by a single aerial placed successively in a number of positions along a railway track. By combining the signals for the individual aerials in certain ways with the aid of the EDSAC computer, the records could be made to yield a complete map in the course of time of all the radio sources 'visible' from the site.

Lively discussion

A lively discussion followed in which many of the younger members joined and which was notable for the able way in which Dr. Hewish replied. In proposing a vote of thanks, Mr. Millington stressed the point that scientists like Dr. Hewish were also engineers who designed and built complicated electronic equipment that had to meet very exacting requirements of stability and reliability. He complimented Dr. Hewish on his lecturing technique and said that in him Churchill College had got a jolly good fellow.

Business aspects

After a break for further refreshment, there was a short meeting to accept the proposal from the chair that Mr. Millington should act as secretary and to confirm the appointment of a small committee put forward by the organizers of the meeting to make the arrangements for the rest of the session. G. M.

BULLETIN OF THE SECTIONS

SUPPLY SECTION

LOOKING BACK

THE past session has again proved full, not only in London but also at those Centres where Groups exist. Although more-detailed notes appear occasionally in the *Journal*, the accounts below will serve to correlate the events elsewhere with those at Savoy Place. Three papers read there last session, together with some papers from the previous session, provided highlights at the Centres.

North-Western Supply Group

The Group was again well catered for during the past session by the provision of a varied and interesting programme, although it is disappointing to reflect that attendances continued to follow the downward trend of 1959–60. The discussion at all the meetings maintained the high standard expected of the North-Western Centre.

The first meeting took place on the 25th October 1960, when the paper 'Field suppression of turbo-alternators' was presented by Messrs. J. R. Hill, A. Hunt, W. J. Joyce and D. H. Tompsett. At the meeting on the 22nd November 1960, Mr. U. G. W. Knight presented his paper 'The logical design of electrical networks using linear programming methods'.

On the 31st January 1961, to the pleasure of the Group, the Section Chairman, Mr. J. E. L. Robinson, an old member and Past-Chairman, graced the proceedings with his presence: Mr. L. Gosland and Mr. R. G. Parr presented their paper 'A basis for short-circuit ratings for paper-insulated cables up to 11 kV' and Mr. G. S. Buckingham presented his complementary paper 'Short-circuit ratings for mains cables'. A lively discussion terminated a very full and satisfying evening that had the highest attendance attained, namely 123 members.

The meeting on the 28th February 1961 was the occasion of the official visit of Mr. F. Lindley, the Centre Chairman. Dr. A. E. Guile presented his paper 'The protection of high-voltage insulators from power-arc damage', followed by a very enjoyable discussion. On the 25th April 1961, the session was brought to a close when Dr. D. H. Grindell presented his paper 'An electrostatic dust monitor' to a small but select group of specialists; the discussion was lively and well maintained. J. B. K.

South Midland Supply and Utilization Group

Five meetings were arranged, two being devoted to Supply Section papers and three to Utilization Section papers. In addition, a Joint Meeting with the South Midland Centre,

the Electronics and Measurement Group, and the Birmingham Centre of the Institution of Post Office Electrical Engineers was held on the 5th December 1960 and a combined meeting with the Centre on the 10th April 1961. The Chairman of the Utilization Section, Mr. J. M. Ferguson, was present at the meeting on the 14th November 1960 and the Chairman of the Supply Section, Mr. J. E. L. Robinson, at the meeting on the 13th February 1961.

Supply Section papers 'A basis for short-circuit ratings for paper-insulated cables up to 11 kV' by Messrs L. Gosland and R. G. Parr and 'Short-circuit ratings for mains cables' by Mr. G. S. Buckingham proved immensely popular when read at a Group meeting on the 10th October 1960. Bearing in mind the local connection, the paper by Messrs. E. H. Cox and R. E. Martin on 'Radiocommunication in the power industry', which was presented at the annual Joint Meeting with the Institution of Post Office Electrical Engineers and the Electronics and Measurement Group on the 5th December 1960, was well received. The paper on 'The application of low-pressure resins to some high-voltage switchgear designs', which had proved of great interest elsewhere, was equally so when presented to the Group on the 13th February 1961.

The average attendance was slightly higher than that in the previous year. An innovation in conducting discussions occurred, in which speakers were given an immediate response by the authors, and this procedure was thought to be an improvement. E. V. H./H. C. F.

Western Supply Group

The Group of the Western Centre commenced a full programme on the 17th October 1960, when the Chairman, Mr. A. H. McQueen, gave his address on 'Research in the switchgear industry and its effect on the supply industry'. A mixture of formal papers and informal talks was given during the session. A film and lecture, at which 103 were present, on 'The Severn crossing' was given on the 21st November 1960 by Mr. C. Morley New, followed by a discussion. A paper 'The shielding of overhead lines against lightning' was given by Dr. J. H. Gridley. The papers 'A basis for short-circuit ratings for paper-insulated cables up to 11 kV' by Messrs. L. Gosland and R. G. Parr and 'Short-circuit ratings for mains cables' by Mr. G. S. Buckingham were read on the 20th February 1961.

An informal paper on 'Construction of nuclear power stations' by Mr. D. M. Longman was read on the 20th March 1961, and a further informal paper on 'The operation of large electrical supply systems' by Mr. L. B. Law was read on the 17th April 1961 before the Group.

A District Meeting was held at Cwmbran. This was very well supported and pointed the way to future activities in connection with District Meetings.

The year was characterized by the energy and interest of members at all meetings, the average attendance being about 80. The membership is 615.

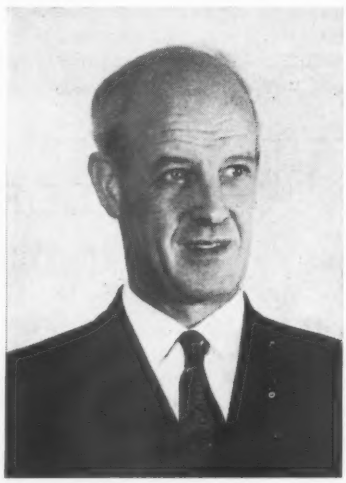
The Section Chairman visited the Group and gave some general information concerning the activities of the Section which was of great interest to all. A. H. McQ.

Looking back, the Groups, although in some instances they have been concerned with attendance levels, nevertheless have reason for satisfaction in their promotion of Institution activities. F. C. W.

LOOKING FORWARD

ANOTHER session has begun, and changes in both Committee members and number have taken place. The election to the Chair of Dr. J. S. Forrest brings a well known and highly esteemed engineer to guide the Section in its expanding and diversified field. His researches on the supply side have a national and international standing of considerable merit. Members will recall, with great pleasure, the presentation of the 3rd Hunter Memorial Lecture last session as only one of his many excellent contributions to the work of The Institution.

The re-election of Mr. D. B. Irving as a Vice-Chairman ensures that his sound counsels will again be available to the Committee. The incoming Vice-Chairman, Mr. D. T. Hollingsworth, brings renewal of the representation of cable activities, and his geniality and other attributes will be appreciated. The return of Mr. L. D. Anscombe, with his association with large-machine design, will be welcomed. Mr. W. H. Dunkley, Mr. J. D. Nicholson and Mr. V. J. Vickers will add lustre to the representation in their spheres of generation, transmission and generating plant respectively.



Dr. J. S. Forrest

Size of new Committee

In recognition of the widening interests, it has been decided to increase the number of ordinary members of the Committee by two, thereby permitting inclusion of representation of the application of electronics to supply engineering. Dr. R. H. Barker of the Central Electricity Research Laboratories will enable this object to be achieved. Mr. W. Casson brings a depth of experience in problems relating to system design and protection.

So, under new leadership, the Committee have begun their work during a session that is charged with much import in the light of impending structural changes. Their deliberations will be full and possibly lengthy, but members can be assured that all will be conscious of the task entrusted to them by the Section. F. C. W.

News from abroad

QUEENSLAND OVERSEA COMMITTEE

Comments on British practice

A MEETING was held at Brisbane on the 29th June 1961, when the speaker was Mr. C. H. Morwood, on the subject 'Experiences as an Area Board assistant engineer and comments on British electricity supply practice'. He described the organization of the Boards in the United Kingdom and made comparisons with practice elsewhere. He explained the equipment in general use and provided numerous illustrations. The audience included a strong representation from the electricity-supply authorities in the Brisbane area, and a lively discussion followed the lecture. The questions sought more detailed information on certain features of United Kingdom practice, and Mr. Morwood dealt fully with all matters raised. A vote of thanks was moved by Mr. Murray and was carried by acclamation.

33kV gas-pressure cable

On the 28th July 1961 we held our annual joint meeting with the Institution of Engineers, Australia, at which Mr. F. Annand presented a paper 'Installation and maintenance experience with 33kV gas-pressure cable'.

The paper was essentially a description of the practical problems encountered with installation and maintenance, and the steps taken to overcome difficulties. It was evident that the approach to installation of this 33kV gas-pressure cable was somewhat unorthodox and that departmental handling of the installation was itself unusual. The resource and courage of the engineers responsible for the successful conclusion of the present programme received high praise, both from the speaker and during the discussion that followed. Mr. Annand showed a number of excellent colour slides to illustrate his talk and had on hand samples of the cables used and some of the equipment to which he had made reference.

The high degree of interest in the lecture was made evident by the brisk discussion that followed. The meeting concluded with a vote of thanks proposed by Mr. Hinkley and carried by acclamation.

W. I. G.

OVERSEA ATTENDANCE REGISTER

DURING the period 17th August to 16th October 1961, these members called at the Institution building and signed the Attendance Register of Oversea Members:

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An Australian graduate being received by the then President, Sir Hamish D. MacLaren, at a reception for oversea graduates at Savoy Place on the 22nd September 1961. The proceedings included the reception by Sir Hamish and members of the Council, addresses by Sir Hamish and the Chairman of the London Graduate and Student Section, Mr. C. F. Price, a showing of the film 'Hazard', and a display of exhibits in the Common Room and of documents and books in the Library. Over 150 oversea graduates from 34 countries attended

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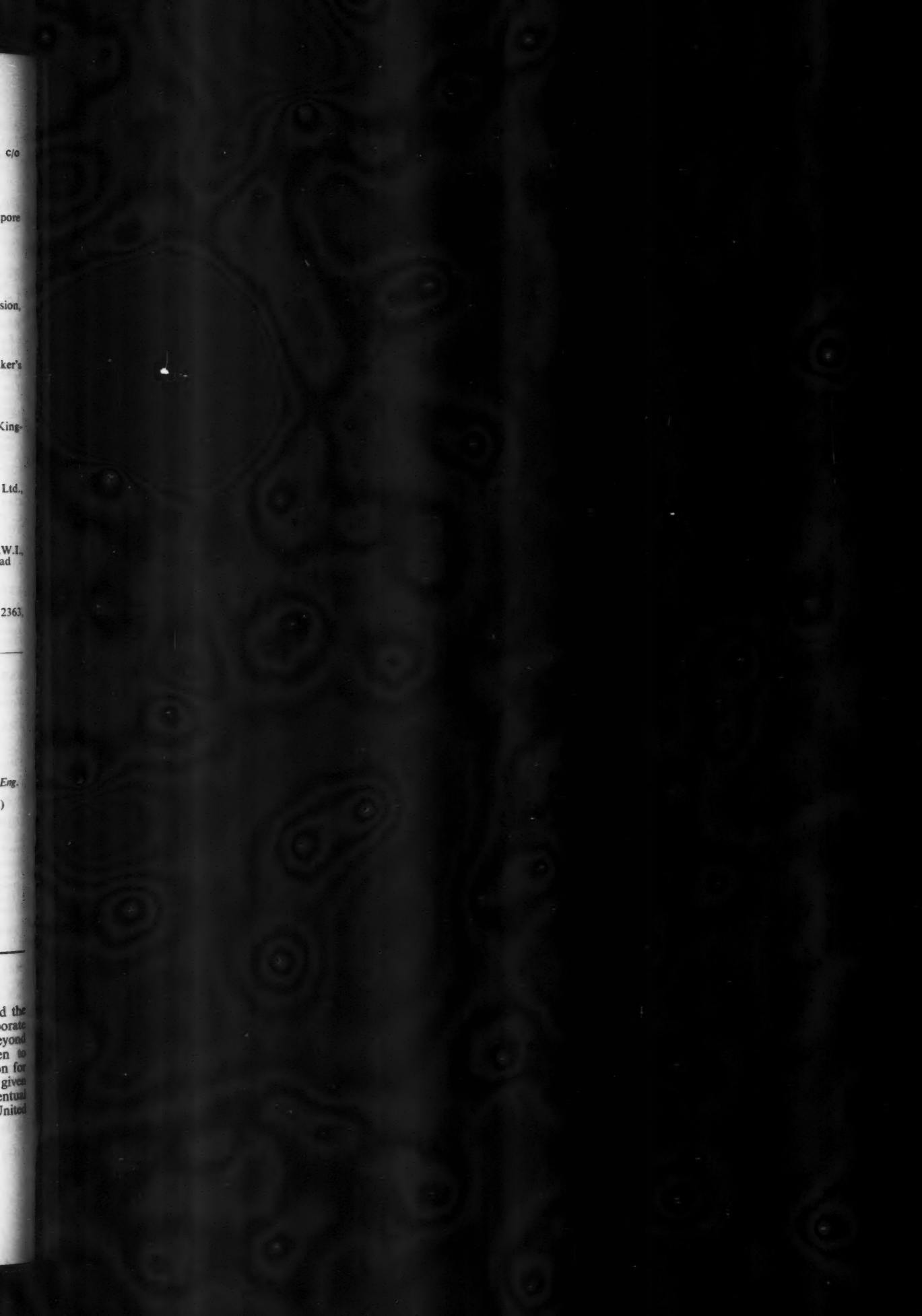
THE United Kingdom Atomic Energy Authority and the Pakistan Atomic Energy Commission are to collaborate further in the development of atomic energy. Going beyond present exchanges of reports and the training given to Pakistan scientists, the two bodies have made provision for staff consultations and for assistance and advice to be given on the uses of radio-isotopes. They also envisage the eventual supply of nuclear research and power reactors by the United Kingdom.